THE

ELECTRICAL REVIEW.

VOL. XXXVII. NOVEMBER 8, 1895. No. 937.

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ELECTRICITY SUPPLY ACCOUNTS.

IN a paper by Mr. D. R. Street, read before the members of the Canadian Electrical Association on suggested forms in "Electric Lighting Accounting," the author has given to the Association various forms which are used by the Ottawa Electric Company for the regulation of their accounts. The forms are given *in extenso*, and although space will not permit of their being dealt with at such length as their importance demands, some remarks upon the more valuable of the methods adopted by this company may be instructive.

The simplification of the applications and contracts for the supply of light, power, &c., is a step in the right direction, and experience has shown, as Mr. Street observes, that customers are often afraid of the very comprehensive documents which are offered for their signature when they apply for an electrical supply.

The order on the storekeeper for supplies required by linemen and wiremen in obtaining from that functionary the materials necessary for their work, is a good one, and could be utilised for every operation in which goods of any description are used, the workman before being supplied with the goods by the storekeeper having clearly described in the column provided, the purpose for which he requires the materials, such purpose having been indicated by the superintendent to the foreman in an order for the execution of the works set in progress.

This system of ordering goods from the stores is one of the best, and one that is in operation in many of the leading factories in this country. It is possibly not generally adopted, and might be with advantage employed in England in central station working. The stores demand orders being signed by the superintendent at the end of, say, each week, enables him to become acquainted with, and check the expenditure of goods. He can thus put his finger upon any extravagance and destruction of goods by careless or incompetent workmen, and is in a position to facilitate the economical running of the station.

We note that Mr. Street confines his orders on the storekeeper to goods required by wiremen and switchmen only, and that other descriptions of goods are arbitrarily allocated from the invoices rendered by the firm supplying them. It would simplify matters considerably if all goods were debited to stores' account, and withdrawn by the orders before referred to, the goods being debited to the costs ledgers under the accounts indicated on the order, thereby crediting the stores' account, and this leads to the consideration of Mr. Street's pay roll. On the back of this is analysed and distributed to various accounts the amount expended on both labour and materials, together with all management expenses, and interest on capital. An allocation of goods by the method explained above, and an analysis of wages upon the basis of the workmen's time-sheets posted to the costs' ledgers, would

dispose of all the working expenses; management expenses, interest on capital, and cognate accounts, it would be well to keep these entirely distinct from ordinary working charges.

The Ottawa Electric Company are not only a supply, but also an installation company, and various forms are given for this branch of business. Experience has shown that the amalgamation of these two distinct branches of electrical industry has not proved a success, and it cannot be doubted that concentrating the energies of the staff upon the supply of the current has almost always been consistently accompanied with more satisfactory results. Mr. Street's register or sales' ledgers are without doubt extremely ingenious (and here it may be noticed that in Ottawa they have to deal with a class of consumers who take current by the week and pay weekly), but they are somewhat complicated, and the functions of a sales' ledger should be to simply record what is owing by a customer, and should not be complicated with data, such as meter readings, number of lights, number of meter, &c. These details should be kept free from pounds, shillings, and pence, and be contained in a separate consumers' register, ruled for the record of such data. An endeavour has been made to deal with the more important suggestions in Mr. Street's paper, and in conclusion, a system viewed from an entirely different standpoint is offered for consideration.

There is no industry whose operations lend themselves to such accurate record as those of a central station, and the natural basis upon which all calculations may be based is upon the unit of electricity generated and sold. In the first place, the registering instruments of the generating station record the output sent for distribution; it will thus be seen that the cost of generating the unit of electricity is the expenditure for a given period, divided by the number of units generated. Such cost is the total of wages and material (under headings in the generality of cases in this country prescribed by the Board of Trade) employed in the generation of electricity and the maintenance of machinery and plant, and each of these accounts may be divided into decimal points by this means, the total being the cost of generation. To this must be added the cost of distribution, a proportion of the engineer's salary chargeable to this head, the wages of linesmen, switchmen, &c., and the maintenance of mains. The cost of distribution added to that of the cost of generation will equal the works' costs of a unit generated. From the readings of the meters the number of units sold is obtained, and the total of the revenue for a given period, divided by this number, will give the amount obtained per unit, the difference between the cost of generation, and revenue obtained per unit, will be the profit that will be available for management, office expenses, and interest on capital. The difference between the units generated and metered should be clearly set out periodically, to determine the efficiency of the system, and a working analysis sheet, summarising the whole of the revenue operations of the company, should be available to give at a glance the result of a period of working.

With an efficient system recording the output of goods, and analysis of wages approximating to the headings of the working analysis sheet formed upon the basis of a unit generated, it is probable that a very high degree of efficiency in central station accounts will be attained, for in the working of a prominent provincial station in England, the difference in the cost of working (which has been taken from week to week) when compared with the result of the year's trading, has been found to be in error to the extent of less than $1\frac{1}{2}$ per cent.; the officers of the company having thus been in possession of the actual results at the conclusion of every week's working during the year.

THE TRAFFIC DECREASE ON THE NEW YORK ELEVATED.

It is not often in a growing city that a means of travel receives a great check, or shows a large decrease in the number of its patrons. Yet this is what has happened in New York with the elevated railways. Our contemporary, the *Electrical Engineer*, of New York, states that whereas in the year ending June, 1894, the number of passengers was $202\frac{3}{4}$ millions, in the next year it had fallen to but little over $187\frac{1}{2}$ millions, a decrease of over 15 millions, though in the same time the surface or tram roads had carried over 30 million more passengers. Our contemporary urges the employment of electric traction to enable the elevated lines to compete with the surface roads. We are quite of opinion that the increase in the surface roads is due to mechanical traction, but we should doubt the benefit of electrical traction on the elevated roads so far as getting back the lost traffic is concerned. The present service may, perhaps, be increased, and that will tell for something, but the great objection is the climbing of steps, and the use of elevators, if such can be arranged as suggested, may prove useful, for it is undoubtedly the steps up from the road which constitute a great inducement to passengers to take the surface cars rather than the quicker elevated cars. In neither is it easy to secure a seat, unless a change has been made of late years, and for short distance traffic it really is hardly worth while climbing up and down stairs, and many people will walk rather than do so. We have fought shy of the stairs ourselves many times in New York.

Estimating the cost of converting the elevated system from steam to electricity, our contemporary sets it down at $5,000,000, which, in 6 per cent. bonds without sinking fund, would require $300,000 of an annual charge, and money could scarcely be had under 6 per cent. in view of the road's pre-existing obligations. If the lost 15,000,000 passengers could thus be regained, the income would be increased $750,000, thus putting the road $450,000 to the good by the change, and our contemporary thinks that by means of electricity, longer trains, or more frequent short trains, better lighted and better warmed, would secure the desired end. But we should ourselves be disposed to lay great weight on the suggestion of elevators. We do not think the public care much whether the trains are run by steam or by electricity; at least, not that section of the public which uses the trains. The man in the street may prefer electricity, because he won't get so much hot water down his neck, or dust in his eyes, but the traveller will welcome electricity chiefly because of the elevators. Indeed, it is not easy to see how the headway can very well be made less than what the 6th Avenue trains have already been run upon.

Some years ago an investigation into the advisability of converting the New York elevated roads to electric traction was made, with the result that the change was not held to be warranted; but it is probable that the case for electricity was not put in the best light, and to-day the question is probably to be considered very differently in the light of later experience, and we think it cannot be long before the change is made. We still think that the passenger traffic will require more than this to keep it up to its level, or again increase it, and if this is to be effected by elevators, there will need to be something smart in this line to fill the need. The rush of passengers at the busier hours will prove a severe test of any system of elevators for which there is sufficient room in the limited space available about the stations.

THE HÖRDE CONDUIT SYSTEM.

After the construction of the Buda Pesth line, street electric railways on the conduit system appear to have been entirely neglected, till they were revived in America in 1893 by the "Love Traction Company."

This company set about the construction of a conduit for the trolley wire, which should at any time and place be easily opened for repair. The drainage conduit, in this system, was made of concrete, so that repairs could not be effected without destroying it. The only difference between the Love and Buda Pesth systems, is that in the former the conduit for the trolley wire is easily accessible, while in the latter, access can be obtained only with great labour and cost.

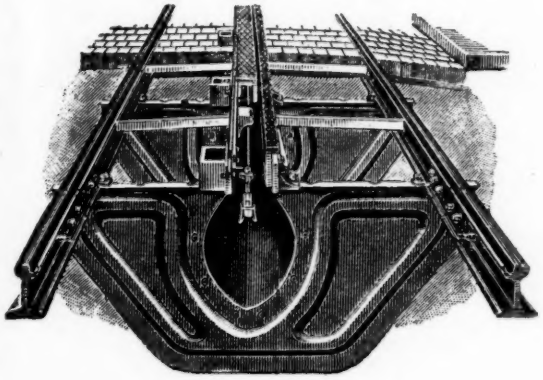


Fig. 1.

In the system which has been carried out at the Hörde Mining and Smelting Works, the aim has been to construct a conduit which shall be strong and cheap, and also readily accessible for repairs in both the drainage and trolley wire sections. A short experimental track on their conduit system has been constructed by the Hörde Bergwerks und Hütten-

Fig. 3.

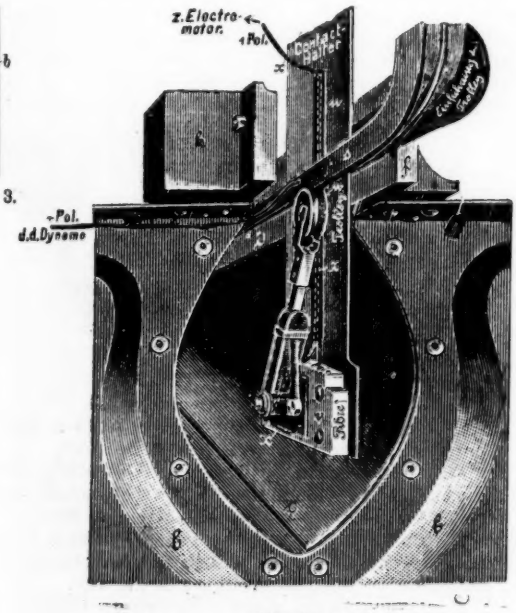


Fig. 13.

verein, in connection with their works, and in combination with a line worked on the ordinary overhead trolley system. The combination of these two systems resulted in showing that two such systems can easily be worked together, using the same cars throughout. This combined working, of course, necessitated that, in the Hörde system, the rails should, as in the ordinary trolley system, form the return conductor.

The Hörde system consists essentially of three parts: 1. A special track. 2. A trolley wire conduit. 3. A drainage conduit.

The details of the construction are illustrated by the figs. 2 to 8 inclusive. Fig. 1 gives a perspective view of part of the track laid bare.

Fig. 2 shows a section of the track taken at the trestle, *l*, while figs. 3 and 4 are respectively a vertical section and plan of the same. Fig. 5 is a longitudinal section through the middle of the conduit, and fig. 6 is a plan with the pavement and soil removed on the left-hand side. Fig. 7 represents a cross section of the track half-way between two trestles and through the bracket, *p*, which supports the wire. Fig. 8 shows a piece of the track 9 m. in length.

The rails, *a*, are fastened by holdfast plates on the trestles, *b*, which are placed at a distance from each other of 1·5 metres.

These trestles are stamped out of one piece of metal plate and furnished with strengthening ribs. They are flanged at top and bottom to facilitate the fixing of the rails, and the bedding of the trestles themselves in the ground. In the centre of each trestle an opening is left corresponding to the section of the conduit.

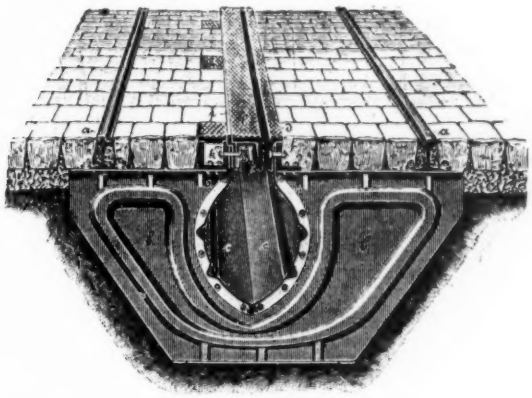


Fig. 2.

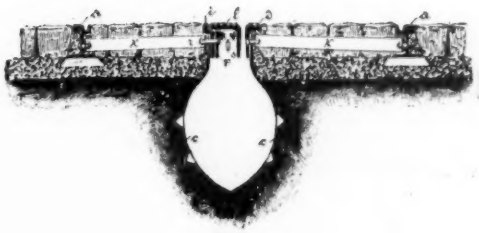


Fig. 7.

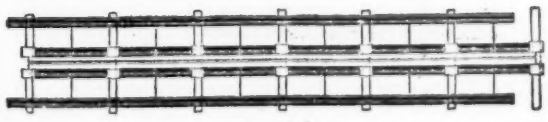


Fig. 8.

The track is the same as the ordinary street railway track, except that the rails are bonded.

The drainage conduit, between each pair of trestles, is formed of two side pieces, *c*, stamped out of steel plate 4 mm. thick, and bolted or riveted together along the bottom. Each piece thus formed is bolted by end flanges to a pair of trestles. The upper edges of this conduit project above the trestles almost to the level of the street, and serve for the attachment of the trolley wire canal. Strengthening ribs may be stamped on the sides of the drainage conduit to enable it to withstand the pressure of the earth. The number of these ribs and the cross section of the canal must be determined by the special circumstances of the case.

The trolley wire conduit in the Hörde system is likewise made of steel, and consists of a space in which the trolley wire is suspended, and the contact slit, *i.e.*, an open slit running the whole length of the track for taking off the cur-

rent. The space in which the trolley wire is suspended is formed by a profile iron, *i*, and an angle iron, *l*. Both run alongside of each other, and *i* is rolled with such a profile that the horizontal limb of the angle iron, *l*, is supported by a rebate on *i* throughout its whole length, while the vertical limb of the angle iron forms one side of the contact slit. The profile iron is bolted or riveted to the upper edges of one of the sides of the drainage conduit.

The angle iron is fastened to the profile iron in the following way:—Short brackets, *n*, are riveted under the angle iron at the places which come above the trestles. The vertical limbs of these brackets lie close to the profile iron, and have slots which slip astride on to bolts which pass through the profile iron, *i*, the conduit wall, *c*, and the side of a cast-iron box, *k*, which in its turn is bolted to the upper flange of the trestle. By this arrangement the angle iron can be readily removed by slackening the bolts in the cast-iron boxes, which are fitted with lids to prevent them being filled up.

The trolley wire is supported by cast-iron brackets, *p*, fixed half-way between each pair of trestles. The wire holder is similar to that in the overhead trolley system, and is insulated

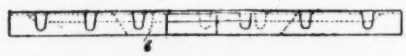


Fig. 4

Fig. 5.

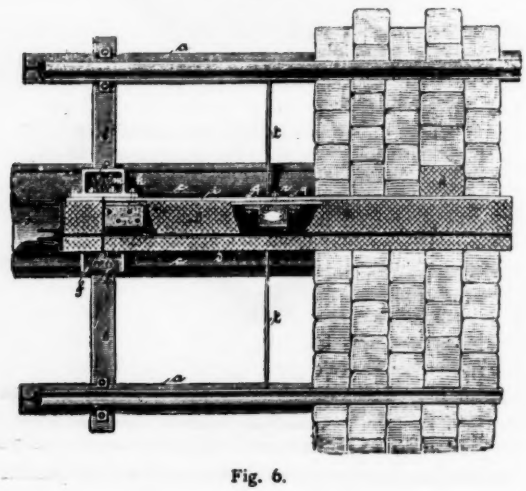


Fig. 6.

from the bracket, *p*, by a conical piece of fibre, which fits into a corresponding hole in the bracket, and is fixed by an oval plate bolted over it. One side of the contact slit, as already mentioned, is formed by the angle iron, *l*, the other side by another suitably profiled angle iron, *d*, which along its whole length is fixed to the edge of one side of the conduit, *c*. This angle iron, *d*, is firmly bolted to the trestle, *l*, by a cast-iron bracket, *f*.

To give greater rigidity and strength to the whole structure, cross-ties, *t*, between each pair of trestles connect the trolley wire canal to the rails.

When it is necessary to repair the trolley wire, this can be done without delay by removing, at the required spot, the cover of the box, *k*, slackening the screws, *m*, and then lifting the angle iron, *l*, by hooks made for the purpose. After the repairs have been completed, the trolley wire conduit is covered up by an equally quick and simple operation. It is not necessary in either case to disturb the street pavement.

The drainage conduit can also be very simply repaired by removing the soil and unbolting the flanged joint at the bottom. The conduit wall can easily be removed and repaired, or replaced by a new one.

Figs. 9, 10, 11, and 12 represent the latest arrangement of the Hörde system, which involves a considerable simplification and reduction of cost. One side of the contact slit in this case is formed by one of the rails. The conduits are otherwise similar to those already described. The trestles, however, are smaller, and the trolley wire conduit is tied by rods to only one rail, since the other rail forms one side of this conduit, and is bolted to the edge of one side of the drainage conduit. There is a considerable reduction of danger to passenger and vehicular traffic in the streets by this arrangement of the conduit alongside one of the rails.

The Hörde tramway is very quickly laid down, since the laying of the iron conduit takes no longer time than the laying of an iron water-main. The laying of curves is somewhat more expensive, as the contact slit must follow exactly the curve of the rails. The drainage conduit, however, may be made straight between trestles, wedge-shaped projections being fixed on the sides of the trestles for attaching the flanged ends of the conduit walls. The Hörder Verein are at present engaged in working out a system of points and crossings for their system.

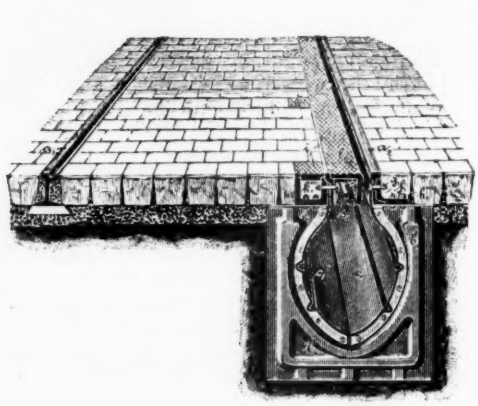


Fig. 9

Fig. 10.

Fig. 11.

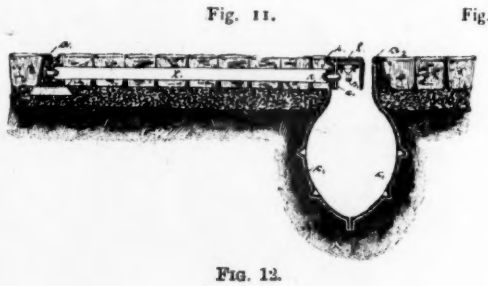


Fig. 12.

The drainage conduit is connected at frequent intervals by short pipes to the drainage system of the town.

The contact holder, fig. 13, consists essentially of a plate, *u*, which passes through the slit into the conduit, where the trolley is attached, by an insulating plate of fibre.

The trolley is supported by springs, in such a way that small side movements are possible, as well as the up and down movements required by contact with the wire.

A curved extension of the trolley wire, as shown in fig. 13, serves to introduce the trolley at the beginning and end of the line.

To protect the conduit from corrosion, all the parts are dipped in hot tar before they are fitted together.

Owing to all the parts being so well tied together, the Hörde conduit is stronger than the concrete conduit. The trestles were found to stand a vertical pressure of 2,500 kg., and the steel sides of the drainage conduit a lateral pressure of 2,500 kg.

The comparative cost of construction of the different systems is of considerable interest. The following has been estimated as the approximate cost of 1 metre of the complete track, including the conductor and its fittings.

	Shillings.
1. The ordinary trolley system, about	40—50
2. Underground system as at Buda Pesth	80—85
3. Underground Hörde system with central conduit	60—65
4. Underground Hörde system with lateral conduit	45—55

The above account of the Hörde system is summarised from a detailed description in the *Zeitschrift für Elektrotechnik*, July 15th last.

ELECTRICAL EQUIPMENT OF MODERN OFFICE BUILDINGS.

Our contemporary, *Electric Power*, in an article by Mr. Joseph Sachs, very correctly denies to Europe the possession of any office buildings that can be compared with the business buildings of America. While we need not be anxious to rival America, and may be very well content not to go beyond six or eight floors, we think that our office buildings might well take a leaf out of American practice. The office buildings of America are like little towns. In some of them 2,500 to 5,000 incandescent lights are installed, apart from motors, and the electric plant is quite an important item in an office building. The engines often exhaust into the heating system of the buildings, and direct connected plant is coming steadily into favour. They are usually compounded, and operated at 110 to 125 volts, though shunt-wound machines are sometimes used. The compound winding is usually arranged to increase the voltage as the load increases, so keeping the voltage fairly constant at the lamps, this regulating effect being varied by a shunt connected round the field windings of the dynamo.

The three-wire system is used in very large plants, current being distributed at double the lamp voltage on the feeders and risers with two dynamos in series and the lamps connected between the third wire and the outer wires. Most offices have the street service as an auxiliary to their own plant, accumulators are of distinct service, owing to the shortness of the maximum load.

About 400,000 feet of rubber insulated wire is used in one building containing 5,000 incandescence lamps. It ranges from No. 16 B and S to cables of thousands of mils. cross section, and is all run in conduits. Current is used to work small fans in the summer season, exhaust fans for ventilation, pumps, and even the elevator is finding the competition of electricity as against the customary hydraulic machines, electrical elevators being variously geared up. In one form there is the same device of multiple sheaves, the power being applied by a nut on a revolving screw rotated by the electric motor. This type of elevator usually has a counter-balance. Such appliances can only be made to pay in well arranged compact buildings, such as the Americans have brought to great perfection. While there is no need to build skyscrapers of the American type, we might very well follow them in reasonable buildings. An American office building is arranged on absolutely simple plans. There is no need to be in doubt as to the floor one is on, nor any difficulty in finding an office. The ridiculous waste of valuable space as seen in the Westminster Chambers, Victoria Street, with a great staircase to every few rooms, would not last a day. One staircase fills the needs of 300 rooms, and for such a number of rooms there will be four elevators continually on the move, and a few seconds places one on any floor.

Considering the many millions of pounds waiting for profitable investment in this country, the marvel is that someone has not seized on the "Warren," or other ill-designed maze, and built an American office building, the upper floors of which would fetch as big a rent as the lower floors. Once introduced, such buildings would furnish an immense amount of business for electricians.

We have such a building in mind, with electric light, steam heating, gas, if needed, and an electrically driven clock in every office, all of which are included in one item of rent.

LOCAL ANNEALING OF HARD FACED ARMOUR.

The difficulty with Harveyised armour plate has been that when a hole is wanted in it this has had to be drilled before the Harvey treatment, and the hole tapped and filled with clay, and it is not always the case that such holes can be set out with an accuracy sufficient for their purpose. After trials with the oxy-hydrogen flame and the electric arc had proved unsatisfactory, the problem was referred to the Thomson Electric Welding Company, of Lynn, and the result is described by Mr. Hermann Lemp, Jun., in a paper read before the American Institute of Electrical Engineers. If by sending a current of large volume through any spot to be treated, the spot be brought to a temperature of 1,000°, the temper will undoubtedly be drawn; but it has been found that when the current has been withdrawn the surrounding metal has drawn out the heat so quickly as to reharden the softened area, and nothing was found to prevent this in the shape of surface protection, but the annealing had to be accomplished by gradual and slow withdrawal of the current. The current is introduced by a pair of water-cooled copper contacts. Immediately beneath the points the plate acquires a bright red colour which shades off to a dull red all round and finally to black. When cooled the annealed portion shows a chocolate colour, but just where the points have made contact will be scaled and hard and cannot be tooled, though they can be annealed by changing the contact points if necessary. The apparatus necessary consists of a generator, transformer and regulator.

The generator is usually a separately excited alternator of variable potential up to 300 volts and 100 ampères, and the frequency low, 50 ~ per second. If more than one annealer is run off one generator the latter has constant E.M.F., the annealers regulating separately by a reactive coil. The annealer is a transformer of well-known welding type. To avoid danger this is copper clad, the primary being enclosed in a closed rectangular frame made up of two copper castings bolted together and forming the secondary. The space between the two is filled with heavy oil which acts both as insulator and conductor of heat. The primary is a copper ribbon insulated with asbestos, and the ratio of conversion is 100 to 1. The transformer is swung in trunnions and hangs much in the manner of a hydraulic portable rivetter. The secondary being, of course, cut through at one place in the circuit, either side of the cut is formed to take various shapes of copper contacts which are of forged copper water-cooled. The whole weighs about 1,000 pounds, which is sufficient to give proper contact pressure, the surface of contact being about ½-inch square, and yet 10,000 ampères flow continually, or equal to 40,000 ampères per square inch—only possible because of the water cooling.

The regulator is simply a rheostat in series with the generator field with, when more than one annealer is being used, a reactive coil interposed. This reactive coil is made up of a solenoid core of well insulated cable with a movable laminated iron core raised by a leather belt and winch. The core tends to return by gravity, but its descent is checked by dash-pots with light mineral oil fillings. In this way the current can be slowly and evenly checked for the annealing process.

When the contacts are placed the current is brought up to 75 or 90 ampères by the rheostat for about 2 minutes, according to the area to be annealed. A pine stick should fire when held in contact with the heated plate. In the absence of a reactive coil the current is then diminished one point of the rheostat per minute. With the coil, the core is raised by the winch, the coil put into circuit, and left to descend under the control of the dash-pot, and the whole operation takes 7 minutes. The success of this spot annealing led to the softening of plates for purposes of embrasure cutting. If embrasures were cut before Harveyising, the plate was apt to warp and crack in the hardening. In softening along a line for cutting, the graduation of the heat is obtained by slowly moving the contacts along the line of cutting. This was first attempted in England by annealing a number of spots so as to have overlapping annealed zones; but with gradual moving the effect is better, and this movement is obtained by a screw and nut, and about ¼-inch per minute is found to be about correct. In dragging the points over the

hardened steel they, curiously enough, cut a chip off the steel surface, themselves being intact after a whole day's work.

The result was that a strip of plate, about 2¼ inches wide, could be tooled. It is suggested that it would be better to make the plate move rather than the contacts. The process suggests for itself numerous applications in safe working, dies and punches, projectiles, &c., and it may be used to create isolated hard spots at the areas of contact when desired. The United States Government has adopted it.

FLY-WHEEL ACCIDENTS.

On October 5th last a fly-wheel burst at the station of the Hudson Electric Light Company in Hoboken, N.J. It was a belt wheel 17 feet diameter, 52 inches wide on the face, and weighed 50,000 lbs. It was built up of eight segments secured to each other by flanges and eight 1¾-inch bolts, and the eight arms were bolted to the middle of each segment by four 1½-inch bolts, and the arms fastened to the hub by three 1½-inch bolts each.

The breakage occurred in the flanges. There appears to have been some kind of safety device to stop the engine if the governor fell too low—as it might do if it lost its belt, &c. —but there does not appear to have been any "knock off" motion to meet both extreme positions of the governor, and the want of this caused the accident, for, the engine slowing down under the heavy load of a short circuit, the attendant is supposed—he was killed—to have held the governor up so that the engine would not be stopped by the safety cam. The circuit breakers then dropped and the engine began to race. They were thrown in but dropped again, and speed increased and alarmed the assistant, who ran to the throttle, but too late. The two pulleys driven by the engine first broke, and the fly-pulley went next, and wrecked the engine. The engines were a pair of vertical cross compound engines of 500 H.P. each, and with Corliss gear. No definite explanation seems to be at hand as to the failure of the governor to check the speed of the engine, for it is not known what the attendant was really doing, and he must in some way have deranged the governor, or lost his head, for there was clearly no further need for him to hold the governor up, and it should have gone up of itself to the stopping position. It may be, therefore, that even if a knock-off motion had been present it would have been a failure, but it is not too much to say that with such a gear the chances are greatly in favour of safety. Such knock-off gears are used on large factory engines where there is a practical impossibility of ever running with such a low minimum of load as is possible in an electrical station. A textile factory, even if all the machinery be stopped, still has its thousands of feet of shaft ing with hundreds of pulleys and belts, and very little chance of much machinery being stopped at one time. There is always a certain steadying load, and this is not so with electrical machinery, and the necessity for knock-off gear is plain, even if, in the case under review, its presence would have been rendered of no avail by the action of the attendant. As to the wheel itself, the plainly indicated weak feature is the flange connection of the rim segments. These flanges are exposed to cross breaking stress. They can only be stiffened by triangular bracketings on each side of the bolts, and these brackets are exposed to tension. It may be questioned whether such bolting flanges ought not to be placed some distance from the abutting ends of the segments of the rim, and supported by ribs extending to the end of the segment and abutting on the similar ribs of the adjoining segment. The junction bolts would be long, and cross breaking stress on the rim would be avoided by deepening the abutment ribs, so as to put a large amount of metal below the centre line of the bolts to balance the rim area above them.

In the ordinary method of construction the flanges are weak and the pull of the bolts is in the direction of producing cross breaking stresses. Judging from the dimensions and weight the rim must have been something like 4 inches thick, and its cross-section must have been out of proportion with that of the eight 1¾-inch bolts, which would extend under centrifugal tension more than they should have done. The illustration in the *Electric Railway Gazette* of the wreck seems to indicate a weak section of arm also, and disproportionately small boss, but no particulars are given enabling this to be known with certainty.

PLEA FOR ELECTRIC RAILROADS.

Electrical Engineering has an article as above from the pen of Mr. A. V. Abbott, but it takes a lot of wading through to find the drift of the article. Beginning with a lot of gush about "struggle for existence," "America a land of homes," "free soil and unbounded opportunities," and a quotation from Tennyson, and going on to refer to the late unpleasantness and the drenching of the land with blood, and scorching of the same to a cinder in order to give the slaves a right to their own homes, we are gradually led up to the consideration of the electric railway as a necessity of modern life to avoid overcrowding. The conclusion is good enough and sufficiently obvious to everyone without the prologue. Noting the growth of American cities and the driving of the farmers into bankruptcy and to the towns, he considers the case of a town without means of transit other than pedestrianism, and allows one hour daily for getting to and from work, which gives a city of 1½ miles radius. We conclude he assumes a speed of three miles per hour. With horse traction introduced and a speed of four miles per hour, the area of the city will be increased from 1 to 1·77. Supersede the horse by electricity and raise the speed to 12 miles an hour, and it may be greater than this in the suburban districts and the area of the city may be increased to 16, the habitable area of a city varying, of course, as the square of the speed of transit on the basis of one hour per day. Of American cities, New York is perhaps one of the worst, and it compares with London in the badness and insufficiency of its means of travel. Boston is very different and may, to some extent be compared with Manchester. True, Manchester has no rapid tramway system, but has railroads whose termini are well into the inner circle of the city, and it is no unusual thing for men having offices convenient to the station to go home for lunch at midday, a distance of 6 to 7 miles—an obvious impossibility in London without much improved facilities. A chart is given which shows that the city population is now increasing faster than the general rate of the country. The chart shows also the mileage of horse and other tramways, horse traction showing a decrease since 1890, cable and steam a practical equality, and electric traction a rapid and steady increase unchecked by the bad times, in spite of the fact that the total mileage increase was at a decreasing rate. All the decrease was in horse roads. Compared with Europe the electrical line has increased enormously. This is due, of course, to several causes, of which our author does not seem aware. In the first place the service performed by tramways in America is largely carried on in Europe by the suburban trains on main lines of railway. There is nothing in America to compare with English suburban railroad traffic. Secondly, the execrable state of American roads has always been a spur to tramway construction, such a thing as an omnibus being impossible, and, finally, the free use of the overhead wire has rendered possible the conversion to electricity which has been impossible here, and we might add that the age of cities here has been against so favourable an arrangement of lines generally. As to fares, the tramways of America have charged less than the railroads, as is indeed the case here, but the American 5 cent fare is high compared with the average English fare. True, it is sometimes available for a 15 mile journey, but 15 mile journeys are few and 10 cents a day is dear for a resident of six miles radius as compared with season ticket rates. Our author considers that if a tramway can be shown to be for the public benefit, the right of way in the street should be granted freely and unconditionally, but he has his eye on the road whose watered stock sells for $200 and refuses seats to half its patrons. At the same time he is unfavourable to municipal control, probably in America he has better reasons than we have to doubt the wisdom of municipal control, which in England seems to work well.

As regards room for passengers, he makes the statement

that "passengers are not sardines to be packed in a box," and we are disposed to agree with him. Where crowding is so great as to leave passengers unseated there is business enough to warrant a parallel line in the next street, and this should be built. Curves showing the expenses and receipts of horse and electrical roads are of interest and show some curious results. With horses the expenses increase up to city populations of 40,000, and then steadily decrease and the expense curve is fairly parallel with the receipts curve all along from population of 10,000 and upward. But with electricity a very different set of results obtains.

Expenses, which for towns of 10,000 are actually above receipts, decrease as rapidly up to 40,000 of a population as receipts increase, and the minimum of expenses at 40,000 almost coincides with the maximum of receipts at 50,000, the moral of which would be, sell out when a town passes the 40,000 mark. But as the town reaches 50,000 and a maximum of receipts is attained, the expenses are again almost equal to what they were in the 10,000 town. Then up to 10,000 both items steadily fall, the expenses more quickly than the receipts. As to division of income, it is laid down that 10 per cent. should be set aside out of the earnings as depreciation to which electric lines are particularly prone by reason of wear, tear, and the march of invention.

Next the bonds of the road must be met to the extent of the legal rate of interest on their face value and then capital stock should receive 8 per cent., the surplus to be held over to make up as above for any bad years and, say, every ten years, half the net surplus should be allotted, half to the city and half to the railway.

To sum up, a street railway should be under the State. Franchises (concessions) should be granted after expert investigation and free of cost and should be exclusive in the area covered and endure at least 50 years. The user of the street shall be safeguarded, accounts properly kept and audited, and the railway and its accounts subject to State inspection, no indebtedness being allowed except for actual needs and the officers to show proofs of competence.

Finally, the municipality shall be responsible for damages due to strikes, insurrections, and other municipal disturbances.

This last clause is good, coming as it does after the author's high flown eulogy of America. It comes quite as a shock, but a worse one is in store for us in the shape of the final table of mileages of electric railway in different countries as follows :—

United States	10,363
Canada	389
All Europe	441
England alone	43

Apart from the reasons which have favoured the comparative extension of tramways in America, such as the better service of the English main line and suburban railways and the poorer service in America, there can be no two words as to the main cause, namely, the free use of the trolley wire. True the American public has objected to the trolley wire because of the dangers which have arisen from badly executed work, and it may be that we shall after all reap the benefit of this. Where a tramway is in question, the American public may be said to occupy the well known position indicated by a certain trite saying, for boards of alderman will grant anything there at a price. There are now no structural reasons why the trolley wire should be tabooed in England, and, as it is acknowledged in Bristol to be not an eyesore, its rapid extension is certain in, we hope, the near future.

There are 14 electric railways in the United Kingdom in operation, 4 in progress and some 14 or so projected, and the longest at work is 8 miles long. This is indeed a poor show.

RAILWAY SIGNALLING.

Mr. G. C. Purvis, of Edinburgh, has patented (No. 6,489, of 1893) methods of improvement in connection with railway signalling. He proposes to indicate to the signalman that his signal is not at "danger" when a train is in the section which it has to protect by causing a bell to ring continuously until the signal has been placed at the "danger" position.

It is doubtful if the method employed would prove successful, inasmuch as immediately on the battery being brought into play it would, to some extent, "short circuit" through the soil between the lines of rails, and it is still more doubtful if the resistance of the circuit formed by the engine when at the most distant end of the section would not (having regard to the defective electrical connections of the fish plates) be greater than that of the "short circuit" across the rails—in which case the bell, if rung at all, would be rung by the short circuit, and not by the engine.

Although it is possible to insulate to some extent the railway metals one from another and to divide them into sections, there is little doubt that it would be attended with so much difficulty, and that it would be so frequently interfered with by platelayers, that the employment of any such system would be attended with great inconvenience.

Assuming the patentee's ideas were capable of practical accomplishment, the condition of things would be as follows :—

In order to ascertain if a train were out of the section, if working by the bell alone, the signalman would have to pull off his signal in order to see if the bell were rung or not, and this would never be allowed, for he might pull off his signal at a moment when a train was approaching, and the lowering of the signal might be taken by the engine driver to indicate that he was at liberty to proceed.

The patentee might, of course, employ an indicator as well as the bell, and in order to obviate the nuisance of the bell continually ringing when not required, he might employ an indicator without the bell. There would be no objection to this, but its action would depend upon the completion of the circuit by the engine and not by the soil between the rails.

Having regard to the fact that block signals are now universally employed, and that these signals indicate the presence or absence of a train in section, it is difficult to see in what manner the ideas of this patentee would be of service—even if capable of accomplishment—to the present mode of railway working.

BERLIN'S ELECTRIC TRAMWAY.*

The Trolley System for Urban Traffic.

The electric tramway from Gesundbrunnen to Pankow was opened to traffic on September 10th, thus bringing the capital of Germany into line with other towns in that country. Commencing in Badstrasse in the north of Berlin, the tramway passes through Prinzenallee, Wollankstrasse, Kreuzstrasse, Spandauerstrasse and Breitestrasse, crosses the Kirchplatz, and runs through to the end of Damerowstrasse. The total length of the line, which is practically double tracked throughout, is 3·4 kilometres, of which ·9 kilometre of line is in the Berlin district.

As long ago as April, 1893, Messrs. Siemens & Halske, the contractors, entered into an agreement with the Pankow Council whereby a concession for 50 years from the opening of the line was granted. Negotiations were then entered into with the Berlin Municipality, who, at the commencement, were hardly disposed to entertain the use of overhead wires; but in November, 1894, when the work in the Pankow district was well advanced, consent was given by the Berlin Council to the establishment of the desired section of the line in Berlin.

The overhead trolley wire is of hard copper 8 mm. in diameter. It is suspended at a height of about 16 feet 6 inches, partly by means of transverse span wires attached to posts erected on the curbstone on each side of the street, and partly by means of bracket standards. The posts are steel tubes made on the Mannesmann system and are based in cement concrete.

The collector is of the stirrup type, which renders unnecessary the use of special switching arrangements in the overhead construction. Where a turn off from one line to another is arranged between the two tracks, this arrangement does not necessitate any special connection between the two overhead wires, since the wide

* Abstracted from the *Elektrotechnische Zeitschrift*, October 31st, 1895.

collector on the car passing from one line to the other does not leave the one conductor (both conductors being slightly approached towards each other at these points), before it has been brought into contact with the other.

The motor cars, of which eight are at present in service, are each equipped with one four-pole motor having a normal performance of 25 H.P. The transmission is effected by toothed gear in the ratio of 1 to 5; the small toothed wheel is of bronze and the large wheel of steel; the whole of the gear running in oil. The regulation of the current is effected by means of resistances; and the speed, which will be increased to 15 miles an hour, is at present at the rate of $10\frac{3}{4}$ miles an hour. The passenger accommodation is for 30 persons.

The power station and the car depôt are situated in Brehmestrasse, and are connected with the line by a single track. There are two tubular boilers, made by Simonis and Lanz, of Frankfort-on-the-Maine, for a working pressure of 150 lbs. The two engines, furnished by the Buckau Engineering Works, are horizontal of the compound condensing type, giving 110 H.P. at a speed of 135 revolutions. These engines are direct coupled to eight-pole dynamos delivering current at 500 volts into the line.

At present a ten minutes service of cars is maintained. The opening of the line has afforded a direct means of communication between the suburb of Pankow and Berlin.

FRANKLIN L. POPE'S ACCIDENT.

In further reference to the said fatal accident which befell Mr. Franklin L. Pope, New York *Electricity* publishes a statement which gives an idea how the accident probably occurred.

Mr. Ralph W. Pope, Secretary of the American Institute of Electrical Engineers and oldest surviving brother of the late Mr. Pope, who has had a long and varied electrical experience, journeyed from New York to Great Barrington to investigate the occurrence, and from the time of his arrival at Great Barrington on 14th ult. up to his departure on the 17th ult., made a daily study of every condition existing at the spot where his brother died. He also carefully questioned every person who had any knowledge of the facts, as no official examination was made beyond the autopsy. Mr. Pope places great confidence in the careful examination of the converters, wires, &c., personally conducted by Edward Weston, Wm. Stanley, and Geo. A. Hamilton, than whom he says no higher authority could be desired. These gentlemen have a report in preparation which will soon be published.

Mr. Pope's story of the occurrence shows that his brother was apparently the victim of an accident, solely due to the fact that in order to test the lines and observe the working of the plant he had permitted the location in his cellar of a converter, which necessitated the leading in of the primary wires of the system, carrying a normal voltage of 2,100. These wires were brought in at the north cellar window at a point distant about 2 feet from the transformer. There was a twisted joint in each wire about midway between the entrance of the primaries and the converter to which they were connected. One of the joints stuck up, and although both were supposed to be covered with so-called insulating tape, it is quite possible that one of the points of these joints was bare, owing to the difficulty of covering such a joint unless extreme care is used. The tape from these joints had been removed after the accident and the wire adjacent to the joints themselves broken on one side and cut with the pliers on the other. The joints were taken out and were found on the floor behind the cold air box on 17th ult. One of the facts which an early examination did not account for was that the main scar on the right hand gave evidence of a mechanical injury, being a deep ragged scratch, as well as a scar from the electrical burn. The point of either of these joints was well calculated to produce such an injury. Two other minor burns, one on the knuckle and one on the back tip of the forefinger, might have been made either before or after the more serious injury.

As he approached the transformer with the lighted lamp in his left hand to look at the wires, it is possible that he first encountered a strong draught from the open cellar window, the sash of which was suspended by hinges, but according to the statement of Mr. Bell, who was familiar with the cellar, had been unfastened for some time and would therefore swing more or less with the wind. It was necessary in order to secure it to push the window back and at the same time turn the button on the end of the sash with his right hand. Having thus closed the window, the withdrawal of the hand apparently brought it into contact with one of the twisted joints already described, by which his body was placed in the primary circuit, the current entering his hand, passing through his body and entering the concrete floor through the soles of his shoes. It is quite likely that the flame of the kerosene lamp may have been blown out before Mr. Pope had closed the window, in which case the liability to an accident of this kind was increased; or some trivial incident may have distracted his attention for a moment.

It was a rainy day and he had walked to and from church, a distance of about half-a-mile, and had also strolled about his yard, so that his shoes were doubtless damp. The wet branches of trees swayed by the wind had also caused grounds on the main line through the village, the consequent flashing having been quite generally noticed that evening. Had he stood closely enough to the window to close and fasten it, he must have stood on a portion of the concrete floor dampened by the dripping of water from the wires which had no "water-drip" outside.

Mr. Weston is of the opinion that the position of the hand after closing the window was at such an angle with the wire that the existing burn could not have been made by the point, although no other theory as to the raggedness of the injury has been advanced. It is evident that no attempt was made to handle the wires in any manner, all the burns being on the back of the hand.

THE INSTITUTION OF JUNIOR ENGINEERS PRESIDENTIAL ADDRESS.*

By ARCHIBALD DENNY, Esq., M.I.N.A.

It has been the custom of your Presidents to begin by thanking you for their election to the Chair, and justly so, because it was a real honour conferred by you, but I have the more reason to thank you, seeing that you have not waited to honour me until I was grey-haired or bald-headed, as the case might be, but have chosen me while still a comparatively young man.

Gentlemen, I sincerely thank you for the honour you have done me, and I shall endeavour to repay you to the best of my ability, by giving you the benefit of what experience I have gained in my short career.

The first question I should like to touch upon is the education proper for a budding engineer, and naturally all through you must take my remarks to refer principally to the two professions of shipbuilding and marine engineering, while I believe you will find them to have a direct application to the other branches of engineering.

Each man has his own idea as to what the education of an engineer should be, and I observe that many of your past presidents have dealt with this subject from their point of view.

I think all young men should start with a good English education, with Latin and Greek not a necessity, and indeed curtailed to the minimum possible. I must say I am not in love with the prevailing system adopted in most English and some exotic schools in Scotland, where Latin and Greek occupy about four-fifths of the boy's time, and recreation, roughly, the other fifth; and I am glad to think that the modern Board School, especially in Scotland, is doing much to leaven the whole lump.

Mathematics—at least, the elements of it—and the elements of mechanics, chemistry, and physics, should be thoroughly mastered, so that at the age of 16, or at the latest 17, provided the boy's physique is fairly developed, his apprenticeship might begin.

Now, I think it must be beyond dispute that, given a lad who intends to tread the higher walks of the profession, and not merely to begin and end as a workman, it is not necessary that he should spend five years at the bench to learn his trade, to gain sufficient expertness in handling the tools, and to study practically the qualities and properties of materials; hence my ideal course is as follows:—

Begin by spending alternately six months (the six summer months) at the bench, and then six months (the winter months) at a first-class technical school or college. As the college or technical school course is generally one of three years, at the end of this time, or in four years at most, the youth should have had enough of the bench, and should be quite ready for the drawing office; the shorter period should suffice in the shipbuilding yard, and the longer period for the marine engineer.

* Delivered November 1st, 1895, at Westminster Palace Hotel, London.

If a shipbuilder, then he must remain in the drawing office, or fight his way up through manager to principal as his ambition, opportunity, and ability lead him. If a marine engineer, then, after a year or two in the drawing office, he should certainly proceed to sea, and, if possible, get his chief, and extra chief's certificate, and thereafter work his way upwards on shore.

This is my ideal course roughly sketched, and one which is being followed out in our yard and engine works whenever possible. Of course, every man cannot afford, or has not the opportunity of following out this course, then all that can be done is to study in the evening (not to too late an hour) and take evening classes. Some of our most brilliant men have succeeded in this way alone, but who can say what they would have been if they had had the advantage of such a course as I have sketched out.

Endeavour to be apprenticed, if possible, to a firm who do not take premium apprentices. The policy of taking premium apprentices is, in my opinion, a mistaken one, both for the employer and the apprentice. The foremen in the works, and heads of departments generally, have the feeling that premium apprentices must be more leniently treated than the ordinary apprentice, and this feeling is sometimes so strong, that we need not wonder at it reacting upon the premium apprentice, and inducing a state of indifference in those who do not start with strong moral fibre. If there are many premium apprentices, their effect on discipline in the works must be detrimental, and even supposing that a few out of the many have a higher ideal than their fellows, it is difficult for them to strike out a different course of action from that of the majority. Not having had personal experience of premium apprentices, my views upon this subject may be rather strong, and I know that many young men find it impossible to learn their profession by any other means, but I think it would be an improvement if firms who do take premium apprentices made it a rule that these apprentices were to be treated in exactly the same way as ordinary apprentices, paid the same wages, expected to fulfil the same conditions, and to be advanced only as a reward of real merit. In that case the premium apprentice would either, as the result of lack of application, simply finish his time an ordinary workman; or, as it should be, his superior initial education with equal application, would ensure his being advanced more rapidly than those who started with fewer advantages, through the drawing office to a position of trust. I have great sympathy with premium apprentices. I think their surroundings render it difficult for them to do their duty, and the spur of necessity is lacking in many cases, but this is all the more reason why I should point out the dangers, and impress the necessity for facing the difficulties and dangers of the position, with a strong determination to overcome them.

During apprenticeship, a lad will doubtless have many opportunities of bringing himself prominently, by good work and conduct, to the notice of his employer and foreman, but while he should seize every favourable opportunity of doing so, he should avoid making himself objectionable by pushing himself forward in season and out of season. To do so will only disgust his superiors, and gain him the dislike of his fellow workmen. Favourable opportunities of bringing himself before the notice of his employer will occur most frequently when in the drawing office, and the best opportunity is when he is given a piece of investigation work, involving, probably, the carrying out of experiments. If any of you are ever in this position, you should be most careful in carrying out the experiments; only draw conclusions after these have been confirmed by a frequent repetition of experiments. Some men have a natural bent towards experimenting; it seems natural to them to tabulate an experiment in the best possible way, and their work at completion is so thoroughly well digested, that the results are easily assimilated by the principal, and hearty commendation follows. Under these circumstances, it is certain that this man's services will be frequently requisitioned; he is thus brought in close contact with the principal, and his rapid advancement ensured. Such cases have often occurred in my own experience. The careful and accurate man appeals to one immediately, and if this is combined with rapidity in carrying out work, his services are highly prized.

Another point I want to notice, and one which has been already touched upon by a recent president, is the question of loyalty to your employers. Undoubtedly this is one of your first duties, and a duty that you owe not only to your employer, but also to yourself, because an act of disloyalty to your employer is really an act of degradation to yourself, even if not found out, a constant repetition of which will so undermine your moral character, that you become an object of contempt to yourself, which appears to me a more serious thing than being an object of contempt to your fellow men; indeed the latter only becomes possible long after the former is an accomplished fact.

I know it is the practice of many draughtsmen to appropriate information from the drawing office in which they are employed to copy plans and tabulated data. Now this, in my opinion, is immoral; besides which I consider it, so far at least as plans are concerned, and also as far as a good deal of tabulated data is concerned, a great waste of time. I have a friend who was once a draughtsman, and he has told me that there are now in his possession many plans cribbed in this way, and that he was incited to do this by the needless prohibition and difficulties placed in his way by a suspicious employer. As a matter of fact, he did not gain any advantage from this, as from the day he cribbed them till now they have never been looked at.

Progress is so rapid, now-a-days, that the mere copyist will always be left behind, and if a man has not sufficient ability from his past experience to scheme out improvements, he will soon be left in the rear along with his cribbed information.

May I read you a few sentences from the General Order Book in force in our yard:—

"As there is growing in our office a large amount of special and organised information procured and organised at considerable expense by us, it must be clearly understood by every member of our staff that we consider this information private, and to be used only in our service. Any member of our staff found copying or removing any of this special organised information will be considered to have acted against honour, and will, on our coming to know of his action, be immediately and without further warning, expelled from our offices. To such a person we will decline to give either reference or character. We consider that the opportunities afforded to the members of our staff in their ordinary work and for private study by our library, are sufficient to enable them to acquire a knowledge of all methods of working by means of which, should they leave our service for that of some other firm, or to start on their own account, they can collect and organise information for their employers or for themselves. There is therefore no excuse for their acting against honour in the way we have now forbidden."

I think these sentences put the matter very clearly and fairly, and may assist young men in deciding upon their course of action. I would therefore counsel you to gain experience and store it in your brain, and make notes only of such general principles as you find in use or discover for yourselves, and do not run the risk of lowering yourself in your own estimation by taking that which is another's.

You should be absolutely loyal to your employer while with him, identify yourself with him in every way and make his interests yours, and when you leave one employer to go to another you should carefully consider how much special information you shall impart to your new employer, more especially if he happens to be a rival to your last.

I would like to give another warning to young men. Cases have come to my knowledge where foreign competitors have by specious promises induced able young men to leave the employ of a specialist in this country, so that he might assist a foreign rival in establishing a similar business abroad. The object was perfectly apparent and was recognised by both parties, I mean both the foreigner and his dupe. A much larger salary was fixed than he was in receipt of previously, with an agreement for a certain term of years. Everything went smoothly until the information possessed by the young man was transferred to his new employer, and then the position became uncomfortable, in fact so uncomfortable that long before the expiry of the agreed upon term of years the young man was glad to leave and return to England, sadder and wiser.

A last hint, and one which I have often found it necessary to give; hold your tongue about what goes on inside the drawing office, especially in regard to proposed work. It frequently happens that from the lack of this precaution, information passing from one drawing office to another induces competition of an unfair nature which otherwise might have been avoided.

Now if you become chief draughtsman you will for the first time have control of a number of other men, and you have added to you a serious responsibility in the management of them. Some men are by nature fitted to rule others; other men, good men no doubt, are by nature quite unfitted to do so, but much can be done to correct this latter imperfection. Constant remembrance of the golden rule—"do as you would be done by," will help; treat those under you with kindness and justice, but at the same time you must be firm in enforcing rigid discipline. One fault which principals find it difficult to excuse and which should always be avoided, is shunting the responsibility for mistakes on to a subordinate with the remark: "I am very sorry, but Mr. So and So made the mistake." This is most disagreeable, and points to a lack of manliness.

A chief draughtsman should take the entire responsibility of the work passing through the office, should take the blame of any mistake upon himself, and not endeavour to shunt any blame on to the shoulders of a subordinate. This should not prevent him at the same time from passing on the remarks of the principal with a few additional ones of his own, in order that the same mistake may not occur again.

Be punctual yourself and insist upon absolute punctuality in your subordinates.

When several pieces of work appear equally important, and it is a question in your mind which to tackle first in the morning, choose the one you like least, and this once finished, the others will go down before you like corn to the scythe of the reaper; this is a golden rule imparted to me by my late brother, which by long experience I have found invaluable.

You will find it a useful thing to keep an agenda or question book, and go over it every day yourself, also if possible with your superior, noting his instructions.

I think I should refer you at this point to a paper I read early this year before the Institution of Engineers and Shipbuilders in Scotland, entitled, "The Drawing Office," in which you will find, I believe, many useful hints as to organisation should you be called to the position of chief draughtsman.

Suppose, now, that you go a step higher, and become manager, your responsibility is further increased, and you have now a new set of conditions to deal with. You should still more closely, if possible, link up your principals' interests with your own. The most serious part of your duty will be in maintaining discipline in the works. Man, in general, is a most complicated machine to deal with, and the working man is, perhaps, the most complicated machine of the human species. In most machines, given a certain set of conditions, you can predict what will happen when the machine works, but often with the human machine exactly the reverse happens to what you might have expected. No minute rules can be, therefore, laid down for the management of men, but you will go a long way towards success if, following out the treatment of your men in the drawing office, you deal with the men in the works in a firm but pleasant way. Be definite in the orders you give, and see that they are promptly and cheerfully carried out. Do not be unreasonable in your demands, and in all your dealings with the men, and the arrangements you make with them, be perfectly honest and straightforward, trying if possible

to put yourself in their place. If you have profited by your time at the bench, you will not find this very hard to do. Where necessary, make written notes of any arrangements as to wages, &c., immediately they are made, read them to the men, sign them yourself, and get them to countersign. Leave nothing ambiguous, nothing doubtful, and, if possible, deal directly with the men, and not with paid agents. You will find under these circumstances that, with few exceptions, the working man is to be trusted and admired.

You must not suppose from what I have said about paid agents that I object to Trades' Unions, but I do object to paid agents interfering at every moment, and with every petty question between master and man. I think that the men are quite able to discuss any detail at a meeting with the manager or master, and that an amicable arrangement is more likely to result from this course, than when an outsider is called in to discuss the matter, who has no real personal interest in the works.

You will find it advantageous to spend an hour in the factory before breakfast; an hour thus spent is worth two later in the day, when it may be difficult to spare the time, pressed, as you probably will be, by other business, visitors, outside contractors, &c., besides which, it allows the foremen to get their instructions for the day, and you have a clearer mind, and are undisturbed by the thought that you are wanted elsewhere. Another reason is that any slackness and waste of time on the foremen or workmen's part is more likely to occur then than later in the day.

Never force a man upon an unwilling foreman. You are often asked, mostly by soft-hearted clergymen, to give some poor weak soul a chance; as a rule, resist the appeal; there are, and should be, exceptions, but, as a rule, you will find it labour wasted.

Remember the cripples; there are always a dozen or so of easy berths which should be kept either for the old or maimed, and even if an able-bodied man gets employment in them, he should at once be removed if a cripple comes along. Of course, I mean your own cripples; don't saddle yourself with other peoples.

An important question is the amount of interference you should allow yourself between foremen and workmen. Theoretically, there should be none; practically, it should be the minimum possible, otherwise your time will be entirely taken up in perpetually listening to two sides of stupid differences. At the same time, you should reserve the absolute power of dismissal or employment, always, however, through the foreman, and, further, your ear should be open to any well-founded complaint of injustice on the part of a foreman to a man. If you are careful in the first two or three cases to dispense absolute justice, you will be little troubled later, because both foremen and men will be watchful of what they do. Keep in view the possibility of nepotism in foremen, and you must be quick to stamp it out; it is most detrimental to discipline. In both these cases you will observe that to manage properly you must have an intimate knowledge of your men.

In a case of any man doing a piece of meritorious work, you will find it a good thing to take personal notice of it; it is the right thing to do, and encourages the man. I have often seen cases where a kind word, some tobacco, or a few cigars, given on the spur of the moment, have been more appreciated than a money gift.

You should take a personal interest in your apprentices, they are your future workmen, encourage them to continue their education in every way possible at evening classes, the better educated they are, and the more they are on a par with yourself the more easy it is to get on with men.

(To be continued.)

THE RATING AND BEHAVIOUR OF FUSE WIRES.*

By W. M. STINE, H. E. GAYTES, and C. E. FREEMAN.

It is with a certain feeling of hesitation that the attention of the general engineering profession is again called to a series of investigations relating to the well-worn subject of fuse wires. Within the past few years a number of able papers on the subject by Messrs. Jackson and Ochsner, Mr. C. P. Matthews, and others, have been presented to the Institute. These have ably supplemented the work of Preece and other foreign investigators, and at the same time developed some points hitherto neglected. The latest contributor to this subject has been Mr. W. E. Harrington, who employed the circuit-breaker in his tests. The literature of the subject has been further increased by several excellent theses emanating from our leading technical schools. The bibliography, too, of this subject, has already been referred to in the *Transactions* of the Institute.

However, the thermal cut-out is still one of the most unreliable of the many devices employed on electric circuits. Its use is universal, but beyond a few practical details the device is but little understood. The blocks in which they are used show some slow improvement, but most of this has been due to the vigilance of insurance boards, and they are still far from perfect. As a source of vexation and uncertainty, the fuse is probably unrivalled.

An analysis of the literature of the subject shows that the theory of the thermal cut-out has been thoroughly investigated. The elements entering its action have been carefully studied and incorporated into fairly satisfactory equations. Yet all tests and treatments have shown the thermal cut-out to be subject to such variations and modifying influences that but little of practical value can be deduced from analytical investigations.

These considerations led the writers to attempt further investigations. The fuse was dealt with as an auxiliary to electrical circuits, and its behaviour under such conditions was carefully studied. The work in great part bears on points already treated of, but it was considered best to study the entire subject afresh, and endeavour to present a more or less complete discussion of the behaviour of the ordinary alloys employed in practice. Naturally, the data obtained has been voluminous, in all some 1,300 determinations; but great care has been taken to thoroughly check all results.

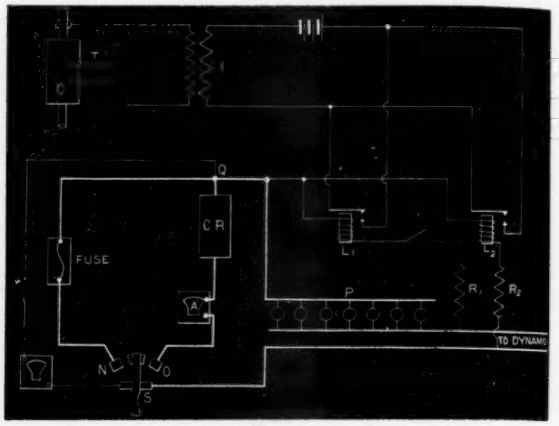


Fig. 1.

The Apparatus.—Fig. 1 is a plan drawing of the main and auxiliary apparatus, with all connections indicated. One of the dynamo leads was brought to the switch, S. This switch was especially designed and constructed for these tests. The pivot was placed well toward the handle to make the travel of the blade as rapid as possible. The carbon rheostat, C R, was built up of carbon plates, whose contact resistance was readily varied by screw pressure. The fuse was tested in a large box lined with asbestos and open at the top, permitting of inspection and access, while at the same time protecting the fuse from draughts. The lamp rack, P, held 100 16-C.P. 110-volt incandescent lamps. These were connected in groups to switches, which enabled any combination from 1 to 100 to be used. A step by step rheostat in multiple with this rack was used to adjust the current through the interval of one lamp.* By its use the current could be accurately adjusted within the limits of ·4 and 60 ampères. For higher currents several similar racks were placed in multiple: L_1 and L_2 were small "pony" relays of 20 ohms resistance, having in series with each five 16-C.P. 110-volt lamps (R_1 and R_2). These relays worked on a current of about 10 milliampères each, and were wired to close the circuit through the primary of the induction coil I. Two storage cells furnished the current for these relay circuits. T was an electro-magnetic tuning fork driven by an independent storage cell; C an iron chronograph drum which was turned by hand. The secondary or spark circuit of the induction coil was connected to the tuning fork and the chronograph drum respectively.

Method of Experiment.—The current to which the fuse was subjected during the test was first measured accurately by throwing the switch on contact, O, and passing it through the Weston ammeter, A. Both the circuits passing from the jaws O and N of the switch to the point of conjunction, Q, were short, and of No. 4 A.W.G. wire. It was thought best to take the resistance of the fuse into account, and adjust the resistance of the ammeter circuit to exactly equal that of the fuse circuit. To accomplish this a current smaller than the known fusing current was sent through the fuse, and the fall of potential from S to Q noted on a Weston milli-voltmeter. The current was next switched on the ammeter circuit, and the fall over this from S to Q, was made exactly that over the fuse circuit, by adjusting the compensating carbon rheostat. The fusing current being accurately measured was switched over on the fuse. The fusing time was thus accurately ascertained. The lamp rack being a non-inductive resistance, the time interval for the current to rise to its full value on the fuse is negligible for all but the very shortest periods. The resistance of the bank of incandescent lamps could not materially alter during the quick throw of the switch, which was thrown by striking it a blow on the handle. Frequent observations made on the lamps did not reveal even the slightest tremor of the light when the switch was thrown. To render the point more certain, the time interval between the break and make of the switch was accurately determined chronographically, and found to vary between $\frac{1}{700}$ and $\frac{1}{1300}$ of a second. The fusing times were noted on a stop watch for all periods exceeding one second. For shorter periods the chronograph arrangement was used. The tracings of the electro-magnetically driven tuning-fork, T, were made on smoked paper fastened over the drum, C. This fork was always rated before each set of experiments by switching it in circuit with a standard-second clock. Its rate was about 67 double vibrations, per second. By frequent timing, all changes in rate due to temperature, &c., were noted and allowed for. The amplitude of the fork was large enough to allow periods of less than $\frac{1}{1300}$ second to be

* Presented at the meeting of the American Institute of Electrical Engineers, New York and Chicago, October 23rd, 1895. Subject to revision.

* For illustrated description of this lamp rack see *Electrical Review*, New York, October 24th, 1894, p. 201.

accurately measured. The records on the drum were made by sparks from the induction coil upon the breaking of one of the relay circuits.

The action of the relays was as follows:—When the switch was on, O, L_1 was closed and L_2 open; when the contact was broken at O, L_1 opened, throwing a spark on the drum, and L_2 closed. The switch making contact at N, L_1 closed and L_2 opened, making the second spark record. When the fuse blew, L_1 opened, causing the third spark record. Though both relays acted synchronously, there was an interval during which the current through coil I was completely broken. Two distinct records were made in every case. The interval between the first and second sparks gave the period of open circuit for the switch, while the interval for the second and third sparks gave the fusing times. The relay circuits are indicated with sufficient clearness on the diagram.

The Experiments.—As our experiments were designed to exhibit the behaviour and characteristics of the fuse used for protecting electrical circuits, it was considered best to adopt not more than two brands of wire for all the tests, rather than employ a large number of varieties. Other investigations have shown that the various makes of fuse wire closely resemble each other in behaviour, and the conclusions obtained with one wire would be general for all. The first make of wire was purchased from supply houses, the second was furnished by the manufacturers.

First Series.—These tests were made under conditions which we shall call commercial, or those which obtain in practice. In all cases the fuse wire was carefully inserted, so as to obtain a uniform pressure of the wire under the screw head without unduly crushing it. The same block was used repeatedly, and little care taken to keep the terminals clean. This was done to more

Table I.

Fusing currents in ampères. Limiting time 1 minute.

	A ½ Amp.	A 1 Amp.	A 2 Amp.	A 3 Amp	A 5 Amp.	A 10 Amp.	A 15 Amp.	B 4 Amp.	B 8 Amp.	B 12 Amp.
Covered Block, ½ in.	2·5	5	10	14	20	35	..	13	..	..
Open Block, ½ in. ..	3	5	9	10	15	25	..	..	..	..
Open Block, $1\frac{1}{16}$ in.	..	..	..	..	..	..	30	..	..	..
Open Block, 8 in. ver.	1·5	3	5	6	9	14	20	..	7·5	
Open Block, 8 in. hor.	2	4	6	7	11	..	20	..	..	..

nearly imitate practical conditions. In only two or three cases out of hundreds of fuses blown did the rupture occur at the contact. Two classes of porcelain cut-outs were employed; one was the open porcelain base "Main Line" style, the other the closed porcelain "K. W." variety. In the latter, the 10-ampère size has a space of only ¼-inch between its terminals, though the fuse is suspended out of contact with the porcelain base. This style of block has recently been condemned by the underwriters, and very properly. With the terminals so close together, a fuse blowing under 20 ampères invariably establishes a viscous arc, and the terminals melt with such explosive violence as to frequently shatter the block. Though the open type of block has an added fire risk, the terminals are, as a rule, further apart. A pronounced fault in their construction is that the terminals are let in flush with the surface of the porcelain. Nearly

Table II.

Fusing times in seconds.

Amp.	I.	II.	III.	IV.	V.
15	84	75 8	...	...	...
20	36·6	35	...	...	...
25	19	17	60	45	195
30	12·8	10·8	33	26	41·6
35	9	7·6	20	16·4	30
40	7	5·8	14	12·6	25
45	5	4·8	10 4	9	17
50	4	4	9	7·4	13
55	3·6	3	6·6	5·8	...
60	3	2·6	5	5	8
65	2·8	2·2	4	4·6	...
70	2·8	1·8	3·6	3·6	5·4
75	2	1·6	3	3	...
80	1·8	...	...	2·6	4·8
85	...	..	...	2·2	...
90	...	...	...	2	3·6
95	...	...	...	1·8	...
100	...	...	...	1 6	3·2
105	...	...	...	1·4	...
110	...	...	...	1·2	2 8

I.—20 Amp. B. Horizontal 8 inches, mica supports each inch.
II.—20 Amp. B. Vertical 8 inches.
III.—20 Amp. A. Horizontal 8 inches, asbestos supports each inch.
IV.—20 Amp. A. Vertical 8 inches.
V.—25 Amp. A. Vertical 3 inches.

all types of porcelain fuse-blocks merit severe criticism on several points. The terminals are too close together in small sizes, the fuse often resting on the top or base; and their mechanical construction is very poor. Too little attention seems to be given to the proper function of a fuse-block in its design.

Table I. needs but little comment. It clearly shows the unreliability of the porcelain fuse blocks used, and also the imperfect commercial rating of the fuse wire, A. The limit of fusing time was 60 seconds. Fuses larger than five ampères will often blow in from one to three minutes on a current somewhat less than stated, but this correction is so slight for these results that it need not be seriously considered.

Second Series.—The open 8 inch block was adopted to avoid all cooling effects from the terminals. When used horizontally, the fuse rested on a number of thin asbestos supports let into grooves 1 inch apart, the fuse being elevated 1 inch above the base of block. In those tests in which the block was placed vertically, hydrostatic pressure lowered the fusing point, but when used horizontally the data may be regarded as the normal fusing points for these various wires.

The data of Table II. will be clearly understood from the accompanying legends. One of our objects was to accurately measure the fusing times for abnormal currents. It is characteristic of all electro-thermal devices that they are sluggish in action. Cases may arise in practice where the insulation of wires is forced to become a fuse competing with the metal supposed to protect the circuit. In all such cases it is only a question as to which shall yield the sooner. There is sufficient evidence in this table to explain why a fuse does not always protect an armature from burning out. The table becomes the more significant in this light when it is noticed that the data has been obtained by the use of an abnormally long fuse block. With the commercial block the fusing times were increased many fold.

(To be continued.)

THE ARC LIGHT.*

By Prof. SILVANUS P. THOMPSON, D.Sc., F.R.S.

Lecture I.—Delivered January 14th, 1895.

(*Continued from page* 541.)

Physical Nature of the Arc.

I ventured, in a lecture I gave here in the year 1889 on the mechanism of the arc lamp, to make some remarks about this phenomenon. I began, however, from the optical point of view, from the researches of Captain Abney, which will engage our attention next week. Captain Abney had found the white surface of the luminous crater to be always of an equal degree of whiteness, which obviously means that it is always of an equal degree of temperature. No matter whether the current going through the arc is small or large, using big carbons or little ones, or whether the arc is long or short, the whiteness of the crater surface is always alike, and therefore of the same temperature. With large currents the area of the crater surface is large; with large currents it is small; its quantity, but not its quality, changes when the current is altered.

I suggested at that date that the true explanation of this constancy in the intrinsic luminosity of the crater surface was that its temperature was fixed by physical conditions. It appeared that whether the current was large or small, the temperature at that surface could not rise, and could not fall; that it was, in fact, as fixed as the temperature at which ice melts or water freezes. The only thing that could account for there being a fixed temperature for the crater surface was the fact that the carbon is at that surface in a state of volatilisation; that the carbon is evaporating off from the positive carbon into the arc or flame.† At that surface you necessarily must have the temperature at which carbon evaporates, just as you cannot have the surface of ice under ordinary conditions either hotter or colder than the temperature which is taken as zero of the Centigrade scale. If you take a piece of ice and put it in front of the fire, the ice itself does not get any warmer; it simply melts off at the surface, the surface of the solid remaining equally cold, as before. So the surface of a piece of carbon, when in contact with its own vapour, must necessarily be at that fixed temperature. That seems to be now the generally accepted idea.‡ I want now, however, to go a little further, and to suggest another idea to you.

It was found by Desprets, about 1850, that carbon, just before it volatilises, becomes very soft; in fact, he obtained good evidence of plasticity in carbons when heated up to very near the temperature of the arc. Now that means, of course, that there is at any rate an incipient liquefaction going on a few degrees below the temperature of the volatilisation. Now, the temperature of liquefaction will also be a fixed temperature. If you have a film of literally liquid carbon lying on the top of solid carbon, there must be a fixed temperature where they come together at the surface where the carbon is melting. There is some evidence that such films exist over the crater surface; but the temperature of the visible surface of the crater is the temperature at which solid carbon volatilises. My present view of the physical state of the arc crater is that the solid carbon below is covered with a layer or film of liquid carbon, just boiling or evaporating off.

* Cantor Lectures. From the *Journal of the Society of Arts*. References to this series of Cantor lectures will be found in the Electrical Review for January 18th and 25th, and February 1st, 1895.

† See an excellent lecture on the "Arc Light," by Prof. Elihu Thomson, in *Electrical World*, xvii., p. 166, February 28th, 1891.

‡ Some recent experiments by Mr. W. E. Wilson (see *Proc.* Roy. Soc., May, 1895) are supposed to throw some doubt upon my theory; they are referred to below.—S. P. T.

The Hissing Arc.

When hissing takes place, a new state of things is set up. If you watch a short hissing arc you will see a column of light concentrating itself on a narrow spot, and that spot keeps moving about, and is very unstable in position as well as in the amount of light it gives out. The contracted spot from which the light seems to start pits deeper into the carbon. I think the first mention of this pitting effect of the hissing arc is not recorded anywhere yet, unless it was mentioned by Prof. Ayrton in 1893 in the paper he read at Chicago, which has never been published. I myself derived the information from Mrs. Ayrton, who made the observation that the crater surface, after the arc has been hissing, is found to be literally honeycombed. When the arc is hissing, you can see little bits erupted out, and the hissing seems to be comparable to the hissing which takes place in water just when it is beginning to boil. If you have some water being heated in such a way that there is not more than a certain quantity of heat given off from the surface, you have the water evaporating quietly, but you cannot get more than a certain quantity of heat given off per square inch of top surface of the water in that quiet way. If you force more than a certain quantity of heat to pass off per top square inch of the water, you find the water begins to break up internally, and you have bubbles formed below the surface, the surface breaks up, the bubbles are thrown out, and you have a noisy phenomenon. I think you will find there is exactly the same kind of difference between the silent arc and the hissing arc as between quiet evaporation and noisy boiling. There is a sort of decrepitation, as though solid particles were being torn asunder to make way for something coming out, when the arc is hissing.*

Location of the Back Electromotive Force.

Another point which remained doubtful for a long time, even after Edlund had made his observations, and these measurements had been made, was whether this fixed voltage that appears in the arc was really the back electromotive force, as Edlund supposed, or whether it was a "transitional" resistance—a sort of resistance located at the surface of transition which, instead of being a constant, as resistances usually are, varied inversely as the current. That was, indeed, Schwendler's view. Schwendler said here is a resistance which varies inversely as the current; when you double the current, the resistance goes down one-half, therefore you want exactly the same voltage as before to drive that double current through. After all, it may be only a *facon de parler* to call this by either name, but, at any rate, reasons can be adduced in favour even of so improbable a view. Suppose there is a surface between a solid on one side and a vapour on the other. Apart from any question of evaporation going, or matter being given off from the solid into vapour at that surface, there is at that surface a difficulty in the current getting out from the material in one state to the other; that resistance will be, other things being equal, inversely proportional to the surface. One square mm. of surface will offer a certain amount of difficulty: with 2 square mm. you will have two possible paths, and the difficulty of transition will be halved. If there is anything that goes by area, then if the resistance is transitional, as it is supposed to be, it will vary inversely as that area. Is there anything that goes by the area? Yes; the size of the arc which determines the size of the crater—I mean the cross section of the arc is found to be almost exactly proportional to the current. If by any possibility you alter your current and pass twice as much current as before, I do not say it will burn equally steadily, but you will find the crater's area will be almost double. This observation was made a long time ago by Mr. J. D. F. Andrews, and is recorded in the *Journal* of the Society of Telegraph Engineers. If, then, the current produces a crater proportional to itself, and the transitional resistance varies inversely with the crater surface, it will vary inversely with the current, and the effect will become the same as though there were a fixed electromotive force. But I do not think that is the true explanation, because I do not believe in this transitional resistance. It seems to be a way of explaining a thing by introducing something which is much less understandable. When you have come to this explanation you have to explain the transitional resistance; but you can explain and see the reason for a counter electromotive force. Whenever work is done by a current in a circuit, it is always done by virtue of a back electromotive force. The fact that there is a back electromotive force in a motor enables you to utilise the electrical energy. The fact that there is a counter-electromotive force in an accumulator that you are charging, enables you to store chemical energy in it. The fact that there is a back electromotive force in an arc enables you to do work in that arc. If there is a back electromotive force, it ought to have a definite seat. Has it a definite seat? Where are these 39 volts? Are they at the crater surface; are they distributed all along the arc; are they at the negative peak? That was one of the points which was entirely uncertain until a few years ago. Several of us have worked at it, Prof. Fleming and Prof. Ayrton amongst others. An observation which I made some years ago was communicated to the Electrical Engineers at the time. I made an arc in the usual vertical way, with the positive carbon at the top. In fig. 4, in order to plot volts vertically against lengths horizontally, the arc is represented as turned over on its side; and the distance between positive and negative electrodes is greatly exaggerated. Into the space between the crater and the peak I then introduced a third carbon to act as an explorer. The difference of potential between the two points, as measured with a voltmeter, was about 45 volts; and to measure this the wires of the voltmeter must be connected, the one to the negative, the other to the positive carbon. But if one wire is connected to the negative carbon, and the other to the third or exploring carbon, one is enabled to go fishing about to find how this 45 volts of potential difference is distributed along the arc. If the arc merely operated as a plain resistance, the fall of potential would be found to be distributed along the length equably; when the exploring carbon had been moved through half the length the voltmeter would just show 22½ volts. But nothing of the sort is found. At a point half-way along the potential was found to be about 4 volts higher than the negative carbon; and as the third carbon was moved towards the crater, this rose to nearly 6 volts. This process, then, enables one to locate the whereabouts of these 39 volts of back electromotive force. Suppose one plots out vertically the results of the observation (as in fig 4), the high level line to represent the potential of the positive carbon, the low level line the potential of the negative carbon; then the volts drop from high to low, somewhere or other in the distance from crater to peak. We might, of course, have measured the voltage drop from the positive carbon downwards, instead of measuring it from the negative carbon upwards. This method of exploration is precisely similar to that known and used for years in examining the polarisation of secondary batteries. Inspection of the diagram that has been plotted from the observations shows that there is a drop of something like 39 volts at the crater, and then there is a slight regular drop all the way down the arc, due to the fact that there is current going through resistance; lastly there is a slight drop at the other end of the peak. I measured that slight drop to be 2 or 3 volts; but in one case, where the arc was hissing, I found at that place a slight rise. Other observers* have

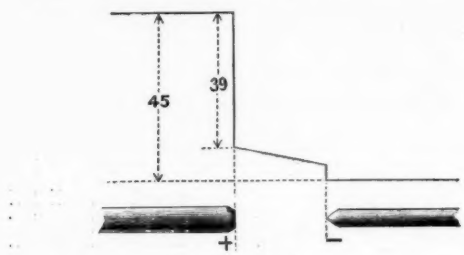


Fig. 4.

also obtained a rise at this end showing that some inverse phenomenon is going on there. The same kind of thing occurs frequently in electrolytic observations. One finds the potential of the intermediate liquid lower than that of either of the materials at the two ends.

If there were a hissing arc instead of a silent one, the drop at the crater would be found to be only about 13 volts there, and the whole voltage from one side to the other would be very much less. Many years ago the observations was made by M. Niaudet that the current, if supplied under certain conditions, increases at the moment when the arc begins to hiss; if supplied under certain other conditions it, however, decreases at the moment when the arc begins to hiss. This apparent back electromotive force has not only been a puzzle to the investigator, but it has led to several fallacious suggestions. There is a remarkable paper in the *Comptes Rendus* for 1884, by the late Prof. Jamin. Jamin was an intelligent man, but he formed this extraordinary opinion that an alternating current arc would necessarily be much more efficient than any arc could possibly be when produced by a continuous current, whether from a battery, an accumulator, or anything else. For, said he, if you work with a battery or an accumulator, that current always flows in one direction, and you have 39 volts against you, that means a pure loss of energy, which is thrown away; whereas if you work with a rapidly alternating current, the back electromotive force will help you at each reversal of the current. Therefore, the alternating current will be very much more efficient. Of course the whole thing is a mare's nest. Jamin did not understand that the essence of getting work out of a current, whether from a motor or an arc, was to have back electromotive force.

Another matter which has never yet been properly cleared up is the transport of matter across from one side of the arc to the other. Unquestionably in a hissing arc there is a large transport; particles of carbon in solid or liquid state being visibly projected across the gap to form the mushroom on the negative peak. Besides this bodily transport, there is probably also a molecular transport by evaporation at one side, and condensation at the other. But the hissing arc is not the normal phenomenon, and the transport of actual particles is abnormal. In a silent arc there is very little. You may, in fact, substitute as a negative pole a piece of metal, if you keep it cool, and prevent it from melting. The evaporation of carbon at the positive surface is quite sufficient to keep the arc going. However, some researches have been made on this point. Sir William Grove thought he got a transport in both directions, as did Matteucci, who employed, instead of carbon, a pole of iron and a pole of copper. On examining the two surfaces after an arc had been allowed to play across, he found that some carbon had been carried over to the iron, and some iron had been carried on to the surface of the copper. But the spluttering effects one gets when using metals in this way make one very unwilling to accept such results as conclusive. A recent experiment of M. Blondel in photographing the image of the arc proves, if anything can prove, that there is only one direction in which material is ever transported, and that is from the positive side to the negative—from the crater to the peak.

* For other observations on the "hissing" phenomenon, see—Cross and Shepard, *Proc.* American Acad., 1886, p. 227. Niaudet, *La Lumière Electrique*, iii., p. 287. Luggin, *Electrician*, xxvi., p. 565. Spencer, *Electrical Review*, xxxiii., p. 496. Andrews, *Journal* Soc. Teleg. Engineers, ix., p. 201. Cravath, *Electrical World*, xix., p. 195.

* Dr. Sahulka, *Zeitschrift für Elektrotech.*, November, 1894; but see J. A. Fleming, "Electric Lamps and Electric Lighting" (*Electrician* Series), p. 155.

Alternate Current Arcs.

I have the means here of showing an alternating current arc. We will turn on the current from the London Electric Supply Company, and I will show the alternating arc first by means of one of those nearly obsolete devices, one of which has now become almost a museum curiosity, a Jablochkoff candle. All honour to Paul Jablochkoff. In the year 1877 he revived this elementary method of providing for an arc; avoiding all mechanism, by simply putting the two carbon pencils parallel at a suitable distance apart, one by the side of the other, with a bit of plaster between. On switching the candle into circuit, the alternating current passes from one point to the other, after being started by a temporary bridge-piece. Jablochkoff used the alternating current, simply because it was essential that the consumption should be equal at both tips. In the use of the alternate current the actions at the tips reverse at every reversal of the current. For an instant the current flows in one direction, then reverses, only to reverse back again. For a brief time the crater will be forming on one tip, and the negative peak on the other; then a very small fraction of a second afterwards the action is reversed, and so the two carbons are consumed away at equal rates. But, for my own part, I do not admire the light from the Jablochkoff candle. It always roars and hums, because of the alternations that are going on. The light is down in a hole between two carbons, so that it is not diffused in the most satisfactory or economical or agreeable way.

High Voltage Alternating Arc.

While I have an alternating current here I should like to show you another arc phenomenon that is not often seen, at any rate, outside electric lighting stations. I refer to the alternating current arc at 2,000 volts. The arc that one gets from a current when elevated to such a high electromotive force as that will be very much more like that which Davy produced with his charcoal points and his battery of 2,000 cells. That is to say, it will be a real arch of flame between two points, and this arch will be blown upwards by the ascending current of air. You will notice that the whole arch itself is more or less luminous. You see that we get great roaring flames, but you will be astonished to find how little carbon is consumed by this 2,000-volt arc. In fact, the higher one goes in voltage with the arc, the less carbon is consumed, and, in some cases, the less light you get. But the consumed carbon is very small, and these flames appear to be rather of the nature of true flames. Only there is this difference; instead of taking combustible materials, putting them together, and burning them in order to get out heat, you are taking materials which do not ordinarily burn together, viz, the two constituents of the air, nitrogen and oxygen, and you are forcing them to burn together by pumping heat into them. It is an endothermic flame, instead of the ordinary exothermic flame. It is a flame which takes in heat from the current, which requires to be fed with heat, in order to exist at all. Certainly some of the luminous phenomena one gets with high voltage, and at high frequency, are of this nature, and, therefore, are not like the true arc. In the arc itself, when made in the air, undoubtedly there is a combustion of the air, that is to say, the oxygen and nitrogen of the surrounding air are burnt together by the heat, and also both of them combine with carbon.

Chemistry of the Arc.

The chemistry of the arc has never been thoroughly worked out. Prof. Dewar, amongst others, has worked at it, and shown that not only do you have carbonic acid and carbonic oxide produced, but nitrogen compounds, prussic acid, cyanogen, nitrous acid, and various others. He drew off the gases through tubular carbons and analysed them.

I do not think any one has in any record called attention to the *smell* of the arc lamp. The arc certainly has a very characteristic odour, probably due to the fact that the carbon is combining both with nitrogen and with oxygen, and that the nitrogen and the oxygen are combining together, giving rise to compounds which, though more or less poisonous, are happily produced in very small quantities, and give a decided odour to the air where an arc is being made. These flaming arcs, at high voltages, very soon produce a perceptible odour; whereas a normal arc, produced actually by 40 to 50 volts, gives very little smell indeed, and sets free extremely little of the disagreeable nitrogenous products.

Magnetic Properties of the Arc.

Amongst the early things that Davy discovered was the effect of a magnet on the arc. He showed that the arc behaved like a flexible conductor, and a magnet being put near it caused it to bend to one side or the other. If the current in it is ascending, it is bent to one side in the magnetic field; and if it is descending, the arc is bent to the other side. In the case of the horizontal arc, it makes a difference whether the current is flowing eastwards or westwards: in the one case, the earth's magnetic field tends to bend it up, and in the other case it tends to bend it down. As a consequence, you can get a larger maximum length of arc with a given current, if the current comes in at the east and goes out at the west, than if it comes in at the west and goes out at the east. Also, with an alternating current arc, where the current flows alternately up and down, the flame of the arc is literally pushed on one side. If you examine an alternating current arc in a mirror that rotates round a horizontal axis so as to get a succession of images thrown out vertically, you will find that those images are successively curved right and left, owing to the effect of the earth's magnetism. Walker and De la Rive observed the arc to rotate round a magnetic pole; and a number of kindred experiments have been made which are very curious. I will only show you one. Here is an electro-magnet which I can introduce into the circuit. I will take a pair of carbon pencils, and placing them between the poles of the magnet, I will try to obtain the arc, using 40 or 50 volts in the arc circuit. You know that ordinarily the arc goes out if the carbons are parted too far. When it does go out it does not make much noise; there is a slight sound like that heard when a candle is puffed out. But try it between the poles of that magnet, what do you find? You cannot even get the arc to keep alight. It flops out instantaneously with a sound almost like a pistol shot. The flame is blown inwards or outwards, according to whether the current is flowing down or coming up. You notice that I put one carbon at the top, and the other at the bottom, and then the magnet blows the flame outwards. If I reverse the carbons and put the negative at the top, the flame will be blown inwards. Even if one works at some distance away from the poles of the magnet, you still observe this very peculiar effect. To burn the arc steadily in a strong magnetic field is almost impossible. If I had a larger electromotive force, say 300 or 400 volts, so that I could support a long flaming arch between those two carbons, and were to form such an arc, it would be blown out sideways, like a blowpipe flame. This was observed long ago by Quet in 1852, and in 1874 by the late Mr. Werdermann, who proposed to employ it as a sort of blowpipe. He set two carbons side by side like a Jablochkoff candle, and arranged a magnet to blow out the flame in a long tongue, for use in soldering or lead burning, instead of a blowpipe. Recently, others have combined magnets with arcs for the purpose of making electric blowpipes. The Benardos process of electric welding and forging is based on this particular use of the arc.

Non-Arcing Metals.

It has often been noticed that certain metals will hardly arc at all in a continuous way. If you take two solid cylinders of zinc, or two cylinders of antimony, and put them close together, and connect them on to the electric light mains, and then start an arc, by sparking across, the arc will not maintain itself. It splutters itself out instantly. This property has been made use of in America, where atmospheric disturbances are much more serious than in this country, for the purpose of constructing a non-arcing lightning arrester. Fig. 5 is a rough sketch of one form of this device. The inventor,

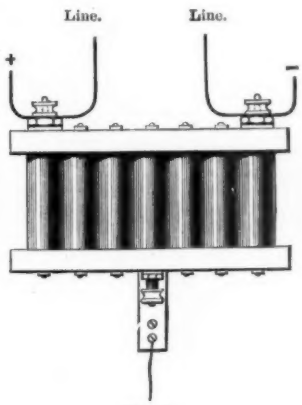


Fig. 5.

Mr. A. J. Wurtz, made an exhaustive research * to ascertain which of the metals do, and which do not arc. He found that nearly all metals will arc, excepting zinc, antimony, and bismuth. Take the case of an electric station, working on an arc lighting system, supplying 40 or 50 lights in series. There is employed a potential of 2,000 or 3,000 volts. If a lightning flash were to start an arc from the outgoing line to the incoming line, it would set up a most destructive arc. In order to prevent any such catastrophe happening, there must be provided a lightning arrester. But the lightning arrester might go on carrying the arc if it were not made of non-arcing material. This is Wurtz's invention:—A cylinder, made of a particular sort of brass, with a high percentage of zinc in it, is connected to one line, while another cylinder is connected to the other line. Between them—nearly touching one another—is a row of intermediate cylinders. The middle cylinder in the row is put to earth. Those on each side are not connected with anything at all, but merely fixed in a frame of stoneware, or some non-conducting material. Then, if either of those lines is struck by lightning, there will be a momentary spark across those cylinders in series, and the discharge will go down to the earth, instead of going to the power-house and deranging the machinery, but it will not persist as a continuous arc; the discharge will splutter itself out instantly. It is not precisely known why this effect occurs with the metals and alloys named and not with others.

Temperature of the Arc.

Until quite recently, the most wild guesses were all that could be learnt about the temperature of the arc, or of its various parts; such numbers as 10,000° C. and 500,000° F. were quite common. Becquerel, in 1860, suggested 2,070° to 2,100° C. as the probable temperature of the arc between carbons, his source of current being a battery of 80 Bunsen cells. In 1879 Rossetti published a research, based on observations of the radiation, in which he came, not without some doubts, to the conclusion that the respective temperatures might be stated somewhat in the following terms:—The temperature of the positive crater somewhere about 3,900° C., that of the negative peak about

* See *Electrical World*, Vol. xix, 1892, pp. 234 and 245.

3,150° C. He concluded that the arc itself, although it gave, being gaseous, less light, was actually hotter, and he suggested 4,000° C. as being the best guess available. Rossetti's value of 3,900° C. for the temperature of the crater has been re-examined quite recently, in America by Nickols, and in France by Violle. By two independent methods of measurement Violle arrived at numbers a little less, his final number at present being 3,500° C. He has arrived at this most recent measurement in a curiously direct way, viz., by a calorimetrical measurement. He arranged an arc in the following manner. The positive carbon was provided with a small end piece, which at any moment could be knocked off and dropped into a calorimeter. This end piece was made the crater of the arc, and was allowed to burn away until it was quite thin; the supposition then being that it would nearly all be at the some temperature as its luminous surface. Then it was dropped off into the calorimeter, and the amount of heat it gave out in cooling was measured. The rather extravagant assumption had to be made, that the specific heat of carbon at this high temperature might be found by extrapolation from its known specific heat at lower temperatures; and the number arrived at agreed with the number derived from the observation of radiation. Mr. P.H. Gray has independently arrived at the value 3,400°. So we may attribute a fairly reasonable accuracy to Violle's number, 3,500°. We know that the lower carbon, the negative, is a good deal cooler. Violle's number for the negative carbon is about 2,700° C. He has recently brought forward evidence to show that the arc itself is probably hotter than either the positive or the negative carbon tip That was previously a matter of inference from the nature of the radiations; spectro-photometrical observations being the basis. The new evidence is this; make the arc using, not carbon, but a material which forms an arc at a lower temperature, zinc being the material in question. The temperature of the crater will, of course, correspond with the temperature of volatilisation of the zinc. Now, if into the flame between the positive and negative zinc tips you use some material which is less volatile or less fusible than zinc, you can again, by the aid of the spectroscope, satisfy yourself whether it is hotter or not. Violle found that the arc between the zinc poles could raise a piece of carbon to a temperature distinctly higher than that of either the positive or negative sides; consequently, by inference, the flame in the carbon arc is hotter than either of the two tips. It is to be hoped that other physicists will work at this question. There is really a great deal to be done on that part of the physics of the arc. Still more recently Violle has returned to the question whether the intrinsic brightness of the crater is independent of the strength of the current. His latest announcement is that when he took a very large piece of carbon, and made arcs with as small a current as 10 ampères, and as large a current as 1,000, the intrinsic brightness of the crater surface, that is to say, the amount of light emitted per square millimetre of surface, was the same.

Effect of Conductivity of Carbon Pencils.

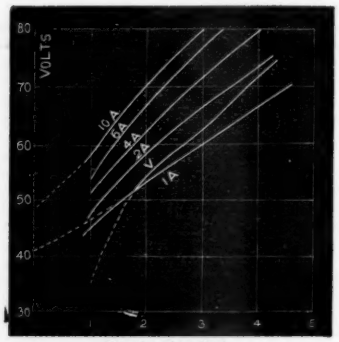
If the pencils of carbon used are of insufficient cross-section, or of a badly conducting material, they will heat throughout their whole length, and waste an undue proportion of heat by offering a useless resistance to the current. From the point of view of economy a good conducting quality of carbon is to be preferred. But, apart from the question of economy, the matter is of importance. If a pencil of insufficient section, in proportion to the current it must carry, is used as the positive carbon, the crater cannot be properly formed, and the arc will be more or less unstable, while the flame will lick around the rim. On the other hand, if the pencil is too thick relatively to the current, the crater will be very deep, and again the arc will burn unsteadily, as the crater shifts its place from moment to moment. For a 10-ampère lamp one frequently finds the positive pencil to be an uncored carbon 9 or 10 mm. in diameter. If a carbon with a soft core is used, a slightly larger size is admissible. It is usual to employ for the lower negative pencil a carbon not cored, 1 or 2 mm. less in diameter than the upper positive carbon.

Fig. 6.

If the carbon is of such poor conductivity, or so thin, relatively to the current it has to carry, as to become red hot for more than a few millimetres beyond the luminous tip, it will waste by oxidation in the air, and become coned for a considerable length. A pair of such carbons are depicted in fig. 6, at A. It was long ago suggested that the conductivity of carbons might be improved by plating them with a film of conducting metal. At B and C, in fig. 6, are shown the forms assumed by carbons of the same quality, when they have been coppered or nickelled. The current flows freely down the external metal skin without materially heating the pencils along their length. In the immediate neighbourhood of the arc the metal is volatilised and disappears. Coppering is now seldom resorted to, as the carbon pencils of modern manufacture are of higher conductivity, and do not require to be coated. The conductivity of good moulded carbon pencils, such as are now used, is from 15 to 20 times as great as that of pencils sawn out of gas-retort carbon, being only from $\frac{1}{10}$th to $\frac{1}{8}$th ohm per foot of length. But coppering would reduce these values ten or twenty-fold.

Effect of Surrounding Gases on the Arc.

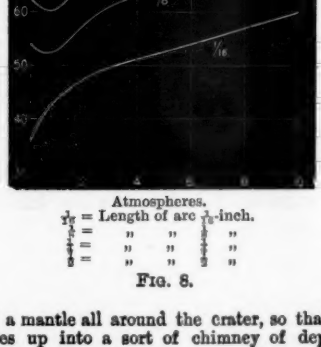
Another matter that has received extremely little attention is the effect on the arc of the surrounding medium. Until recently, it was not known what would be the effect of increasing the pressure of the air, or of surrounding the arc by different materials instead of atmospheric air. At a time before this 39 volts of back electromotive force was as well recognised as it is now; it was supposed that this constant part of the voltage had something to do with the surrounding air; that, in fact, it was due to the oxygen and carbon combining.



Tenths of an inch.
10 A = 10 atmospheres.
6 A = 6 "
4 A = 4 "
2 A = 2 "
1 A = 1 "
V = vacuum.

Fig. 7.

In order to disprove this notion, I had some experiments made* three or four years ago with arcs burning in different materials, in chlorine, in coal gas, in hydrogen, in nitrogen, &c. I found that it did not make 1 volt difference what the surrounding gas was. The 39 volts were still required as the minimum electromotive force for a steady arc. Incidentally I observed that the shape of the positive crater and of the negative peak is quite different, and differs in different gases. In coal gas one finds that the hydro-carbon becomes deposited



Atmospheres.
$\frac{1}{16}$ = Length of arc $\frac{1}{10}$-inch.
$\frac{1}{8}$ = " " $\frac{1}{10}$ "
$\frac{1}{4}$ = " " $\frac{1}{10}$ "
= " " $\frac{1}{10}$ "

Fig. 8.

in the form of a mantle all around the crater, so that the negative peak penetrates up into a sort of chimney of deposited carbon. When one works at reduced pressures, one begins to get into the vacuum tube order of phenomena. The arc may be drawn out to a great length, and expands in size; but the luminosity of the tips of the carbons diminishes, and the phenomenon of the crater changes. Very little carbon is volatilised, and the electromotive force required to sustain the discharge is lessened.

When, however, one increases the pressure, one meets with arc phenomena that are slightly different from those at atmospheric pressure. Here we have the justification of the view that the 39 volts is due to the work done in the vaporising of the carbon. So far as I know, much the most complete experiments yet made on this point are those made in America by Dr. Louis Duncan,† and some of his students. Figs. 7 and 8 embody in diagrammatic form the principal results of the researches.

* See *Electrician*, xxix., p. 460.

† L. Duncan, A. J. Rowland, and C. Todd. See *Electrician*, xxxi., p. 360.

Duncan caused the arc to be made in a vessel into which the air could be pumped, or from which it could be exhausted. Take first the case of the arc made at the ordinary pressure of one atmosphere. The sloping line marked "one atmosphere," in fig. 7, here shows the connection between the volts and the length of the arc; the lengths in successive experiments being plotted out horizontally in $\frac{1}{10}$ths of an inch. We have in general the same sort of sloping things as previous experimenters have found. But the lines that correspond to different pressures all slope down from right to left. They are not all straight, though straight over a considerable range. The "one atmosphere" line is not quite straight, for it begins to turn down when the length is small. But its straight part points toward 40 or 39, according to current that is being employed. Now if my theory is true, that the arc temperature is that at which carbon is vaporised, it follows that if you put on the pressure, you ought to have exactly the same sort of effect as happens in boiling liquid when you put on pressure; you raise the temperature of boiling. In the present case you raise the temperature of evaporation, and require more energy to make it boil; that is to say, it will boil, other things being equal, with a bigger back electromotive force. The diagram shows the line for two atmospheres, for four, for six, and for ten. Let us pass at once to the last as being the extreme case. The "ten atmospheres" curve points back to 48 volts instead of 39, proving, in fact, that more work is done by the current in going through the arc when it is made more difficult for the carbon to evaporate from the crater into the arc itself. There are some other things which might be noticed in this figure. For instance, when working in a vacuum, short arcs require less electromotive force, and long arcs a greater than is required in air at the ordinary pressure. The next diagram, fig. 8, is also one of Duncan's, plotted out in a different way. Here he is employing a constant length of arc, but varying the pressure. As you increase the pressure from vacuum first to one atmosphere, then to two atmospheres, and so on, you notice what happens. With a very short arc there is a continuous increase in the volts required, but if the arc is $\frac{1}{8}$th inch long, and you pass from vacuum to one atmosphere, you want fewer volts. It is easier to send an arc through air than through vacuum when it is only $\frac{1}{8}$th inch long, but after that the electric pressure required increases. Suppose you begin with a $\frac{1}{2}$-inch arc, there is a very distinct lowering of the voltage, but a little over 5 per cent. in amount. Yet, on raising the pressure above one atmosphere, the voltage again increases. All this points to something not yet discovered.

(To be continued.)

HIGHER VOLTAGE RECOMMENDED FOR HULL.

At a meeting of the Hull Corporation Electric Lighting Committee, held on 31st ult., the following report from the engineer, Mr. Alfred H. Gibbings, was presented:—

In accordance with the request of the committee, I have now pleasure in submitting the outline of a scheme which has already been under your consideration, for adopting a pressure of 220 volts as the minimum supply pressure, in place of the 110 volts already in vogue.

I will assume, in the first place, that the committee are well aware of the general advantages which would accrue from the suggested alteration, the first and foremost of which is the increased area of supply. The radius from the Central Station in which mains could be laid would be extended to one mile, and the area which we should then be enabled to supply would be increased to approximately four times the present area, as represented by the outer circle on the plan of the town before you. I have not, however, contemplated such extension in the subsequent figures given in this report, because such extension is confined to the cost of laying mains, and would not involve any further alteration; but even as far as the mains which are already laid are concerned, the following advantages would be gained:—

1. Twice the number of consumers for which the present mains were designed could be supplied without increasing the size of the mains in any way, that is to say, the present carrying capacity of the mains would be doubled.

2. The variations in the pressure caused by public arc lamps and private motors would be reduced to one-half.

3. Twice as many arc lamps for public street lighting could be run in series off the mains, hence every eight to ten lamps in one street could be controlled at one point, instead of the present maximum of four or five.

4. Much greater horse-power would be available for private motors, without causing objectionable variation on mains.

5. Electric trams could be more advantageously run, whether on the overhead or accumulator system.

6. The cost of laying service lines to consumers' premises would be reduced to one-half the present cost for cables, hence the total cost per annum (which is a capital outlay) would be, at the present rate of increase of consumers, reduced by £100 per annum.

7. Half the sectional area of cable at present necessary in consumers' own installation would be saved, hence the initial cost of installation to each prospective consumer would be correspondingly reduced, and the first cost would thus form a much less serious objection than at present.

In order to effect the change in the present area, I think it would be advisable for the committee to purchase an equal number of lamps to, and exchange them for, those in use in the town at the time, the change being effected section by section, taking probably six or eight months to complete, thereby causing no trouble or inconvenience either to the station or the consumer. For this purpose I have prepared a tabulation (placed on committee table), which I also submit herewith, showing the number and candle-power of incandescent lamps, arc lamps, motors, &c., used by each consumer who was connected to the mains at the end of September, 1895, so that the committee will be at once enabled to see what alteration will be necessary under 220 volts pressure in the case of each individual consumer, and these I have summarised and included in the following details of the total cost of effecting the change.

With reference to increasing the size of the mains to double their present capacity, the figures in the foregoing table are based upon the amount of copper which would be necessary in order to accommodate twice the present number of consumers. The same reasoning, very much more forcibly, applies to the time when it might become necessary, under the present pressure, to double the whole of the mains throughout the town, which would involve a very heavy capital outlay, but the figure which I have taken above represents an expenditure which would certainly have to be incurred within the next two or three years.

The actual cost, therefore, of changing over at the present time, or at least within the next 12 months, would be roughly about £1,500. But this amount would be increased very largely by delaying for 12 months. There are several good 220-volt lamps in the market, and the samples which have been already sent in to the specification which I recently drew up appear very satisfactory, and, therefore, I should strongly recommend the committee to at once take the question into serious consideration.

The Chairman (Mr. Holder) said that the only question was whether the Board of Trade would allow them to use the system. It was further explained that by the adoption of the system, they could supply double the number of consumers at present provided for, and go double the distance. The actual cost of the alteration would be £3,362 13s. 9d., but it was estimated by the engineer that there would be a return from sale of replaced lamps, and an increased number of customers, which would leave the actual cost of the complete alteration at £1,525 1s. 2d.

It was ultimately resolved that the report be entered on the minutes, and its consideration deferred, pending the coming conference with the Board of Trade.

GOVERNMENTS AND TELEGRAPH MONOPOLY.

In the various notices which have appeared in the daily Press concerning the Island of Trinidad, it has not been made sufficiently clear that the complications with Brazil are a legacy ("damnosa hæreditas") from the late Government, and if, as would appear to be the case, the action taken by the Brazilian Submarine Telegraph Company has done much to arouse the resentment of the Brazilian Government, and to impart an element of bitterness into this dispute, it should cause neither surprise nor regret were the present Government to withdraw from a position which at the best is, apparently, none too well-founded, and which has been made still more embarrassing by what the *Daily News* describes as "a not too creditable telegraphic intrigue."

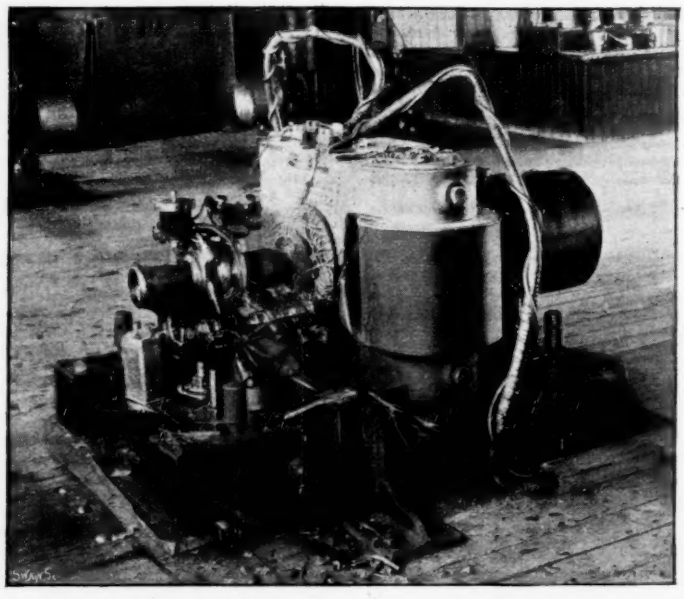
Our readers may remember that some time ago an additional difficulty was thrown in the path of the projected scheme for a cable to unite Canada and Australia, by the negligence of the late Government in dealing with the suggested cable landing at Necker Island, in the vicinity of the Hawaiian Archipelago. In this case, however, although urged by strong representations made by Colonial Governments, the late Administration delayed until the island in question had been formally annexed by the Hawaiian Government; thus, to a certain extent, strengthening the monopoly of the existing cables to the East and Australasia.

We have before us the report made by the Brazilian Department of Telegraphs to the Minister of Industry and Public Works, in which the position of the Brazilian Government *vis-a-vis* the Brazilian Submarine Telegraph Company, and other submarine telegraph companies, is explained at considerable length, and an analysis is made of a "memorandum" presented by Sir John Pender to the Brazilian Minister in London. In this memorandum, Sir John Pender says:—"The companies (referring to the Western and to the Brazilian Submarine) were organised in 1873. Until then Brazil had no telegraph system crossing the ocean. The Western was formed to establish coastwise communications beyond Pernambuco. The two companies ought to be one only, the whole work being embraced by one concession, but in order to facilitate the raising of the capital, and to apportion out to the whole of Brazil the desired telegraphic communication with Europe;

two companies were organised, and they, with full knowledge and approval of the Government, made an agreement for 20 years to jointly work the concession, and to divide the receipts—such agreement being necessary."

This statement clearly refers to matters of fact, but in the report which gives the details of the various concessions, we find the following: "Without, therefore, bringing forward other provisions, it is clearly seen that the present 'Western' is the product of various amalgamations and transfers of other concessions. There is, therefore, no truth in the assertion that the companies were organised to work a single concession which embraced the whole work, nor in the statement that the circumstances of there being two companies was caused by the necessity of facilitating the raising of the capital."

The report also goes on to quote from the Departmental Report of 1874, to show that as to the joint purse agreement made between the Brazilian Submarine Telegraph Company and the Western and Brazilian Telegraph Company the Brazilian Government were not consulted, and adds: "It can be seen from these two quotations what were the intentions of the companies in entering into their agreement, and further that the division of receipts was not approved by the Government, nor even made with its knowledge," and adds the following: "The monopoly of the International service created by the privilege granted to the Brazilian Submarine was prejudicial to the Brazilian telegraphing public, owing to the continued heavy charges, and not less so to the interests of the Government, owing to the deviation of traffic from the landlines by reason of that company's agreement with the Western, of June 13th, 1873. This decided the Government to promote competition by the establishment of a new cable, which, while respecting the privilege of the Brazilian Submarine, would bring about a reduction of the rates at that time collected, and work in mutual traffic relations with the landlines which were almost entirely excluded from the International service."



Break Up of a Commutator (page 577).

An alternative cable was laid by the South American Telegraph Company, and the manner in which this line was opposed is shown by the following transcript:—

"A very serious question which arose towards the end of 1892, at the time of the opening of a new route, has only been solved at the close of the year 1893, after necessitating a most energetic correspondence on the part of the International Office. Certain cable companies (Brazilian Submarine and Western and Brazilian) which had been founded earlier, considered themselves entitled to refuse for over a year correspondence proceeding from or to the new route, although the tariffs had been properly published by official notifications, and there was no question of competing rates, as the charges by the new route had from the beginning been equalised with those of the existing routes. This attitude has provoked a threat of effective intervention from one of the administrations most directly interested in the question (Argentine Republic). After long and unfruitful negotiations, and in consequence of the persistent refusal of the companies to submit to the spirit and letter of the Regulations, this administration, on the strength of Article 8 of the St. Petersburg Convention, instructed the International Office to notify the suspension of private telegraph traffic through its territories in respect to correspondence proceeding from or to the obstructive companies.

"Before giving publicity in the official notifications to this decision, the legality of which has been vainly contested by the companies, the International Office made a strenuous effort to lead the said companies to normally perform their service. After long hesitation, prolonged to the extreme limit granted in deference to the wish of certain high intervening parties, the companies at last renounced their system of obstruction, and consented to accept as from the 1st January telegrams proceeding to or from the rival route."

CORRESPONDENCE.

Unwarrantable Competition in Electrical Wiring.

Mr. Peto appears to consider the very large differences in electric wiring contracts are due to the large number of new firms starting in the business; it would certainly be a very good thing if those of us who were electrical contractors, say, only twenty years ago, could have the matter all our own way now, as we did when the training grounds for electricians were very few.

In face of the fact that thousands of young fellows are now annually training for the electrical profession or trade, and many hundreds of them, who are of an age and have the necessary capital, very naturally are anxious to try and do the best they can for themselves, either professionally or in trade, no doubt many who start and fail in the former, take to the latter, and, so long as the demand for electrical work to be done is so far below the supply of competent electricians, some other means should be found to endeavour to stop the "unwarrantable competition" of which Mr. Bergtheil and your other correspondents complain.

During the last fifteen years I have been interested more or less in "electric light wiring competitions," and have from observation of the results, arrived at the conclusion that the present unsatisfactory state of things is, to a large extent, due to the fact that a great many electrical contractors do not attempt to take out proper measured quantities when making their estimate, but simply arrive at the supposed value by priceing out the number of lamp points. From my experience this is a most misleading method, and variations, far greater than those quoted by Mr. Peto, may be expected. The comparison which he also makes, between a building contract and a certain electrical contract, is a key to the whole thing, as in the building contract quantities were provided, and in the electrical contract they were not.

Why should not the Institution of Electrical Engineers consider the advisability of starting a new branch of their profession viz., "electrical surveyors," and place their plans and specifications into such hands, for the purpose of taking out quantities, in the same way as architects do with building surveyors? To my mind this would have a most healthy effect upon all competitions in which quantities were provided.

Another stumbling block for electrical contractors I believe to be the cutting away and making good clauses; many men who are well trained in electrical work have but a slight knowledge of building construction, and, on the other hand, builders have perhaps less knowledge of electrical wiring, and the difficulty is, as a rule, to obtain a proper estimate of

the value of "attendances upon electricians." It is here that the electrical surveyor would prove most serviceable; he would, of course, make it part of his duties to prepare a bill of quantities of such attendances, separate from the wiring work proper, and the same could be handed to the builder to tender upon, and so relieve the electrician of work which, generally speaking, he would rather not undertake.

These few suggestions are all thoroughly practical, and such as are being used daily in all accessory trades to a building contract—except the electric light wiring—and, now that this is a necessity to all new buildings of any importance, if we do not soon have "electrical surveyors" trained in building attendances, we must not be surprised to hear of building surveyors trained in electric wiring.

James Wenham.

November 4th, 1895.

It may prove an interesting addition to the correspondence on this subject to record the fact that in a neighbourhood near London there is a man who advertises that he will do electric light fitting at the rate of 13s. 6d. per light—fittings and all! His ostensible business is anything but that of an electrical fitter, and your readers will be able to judge for themselves what quality of work is possible at such a price.

W. Perren Maycock.

November 2nd.

Commutator Break Up.

I enclose photo (shown on previous page) of the break up of a commutator of a Manchester dynamo, 120 ampères, 110 volts, 1,300 revolutions. While, I presume, it is a rare occurrence, or, perhaps, I should say "rarely allowed to occur," I think it of interest as showing how long the thin segments resisted the stress to which they were subjected.

The commutator was last turned up on May 7th, leaving the segments $\frac{1}{8}$th-inch thick, and ran until August 4th, when the break up occurred, the segments then being $\frac{1}{16}$th inch thick.

The dynamo is running day and night pumping water, the motor taking 18 to 20 ampères, in addition to which the night load of lamps is upwards of 80 ampères, the machine being run up to the full voltage. The period between the dates mentioned being our winter, the dynamo was only stopped on Sundays from about 7 a.m. to 4 p.m.

This dynamo, I might also mention, is subject to a great deal of vibration from various causes.

R. H. Brooks.

Electrician's Department, De Beer's
Consolidated Mines, Kimberley,
October 4th, 1895.

"The Choice of Transformers."

Replying to Mr. Adams's letter in your issue of November 1st, I beg to inform him that the transformer is of the closed magnetic circuit, and not of the open circuit type as he suggests.

Mr. Adams says that he can get the double secondary on his transformer without altering the iron; that, in itself, shows the bad design of the transformer, and accounts for the high iron loss.

As regards the other point, viz., 2,000 or 1,000 volts, I still maintain that it is equally easy in every way to design and build a transformer for either of the above voltages to be as efficient as the American transformer instanced by Mr. Adams, and that primary voltage has nothing to do with efficiency.

S. R. C.

Compounding Dynamos by Armature Reaction.

I wish to say in regard to the letter of Mr. W. B. Sayers, of October 5th, 1895, appearing in your issue of October 11th, that I think I fully appreciate the effects of armature reaction in breaking down the wound field poles, and in producing even an opposing electromotive force. This would be in itself evident from what has been long known concerning the actions of dynamo machines and would need, of course, no reiteration on my part; and it would also be evident from an inspection of my fig. 11. I cannot, however, accept Mr. Sayers's extension of said figure in his letter referred to. I think that if he had extended my curve from its extremity backward towards the origin, curving it up near thereto, it would have been far less steep than is the curve represented by his dotted lines, and would have shown in a sufficiently clear manner the effects of the differential field resulting from the armature magneto-motive force overcoming the field magneto-motive force.

Mr. Sayers asks for information in regard to the effect of the movement of the commutator brushes backward, which, with carbon brushes was attended by a steady fall of potential without perceptibly increasing the spark. It is true as Mr. Sayers says, that degrees of sparking are difficult to observe when carbon brushes are employed, but he goes on to suggest that possibly the observation would not be confirmed if the experiments were repeated. Mr. Sayers could not be expected to be aware of the fact that the machine was run on a number of different occasions and that invariably this same effect was observed. Indeed, it was so marked and curious that the experiments were purposely repeated many times in order to note it. Even with copper brushes it was found that the movement of the brushes backward could be made with but a moderate increase of the sparking, and there was by no means as much sparking produced as would be expected from ordinary machines carrying an equal load, even at the diminished potential, if the brushes had been set back to the extent they were in the set of experiments forming the basis of my paper. I can only make the hypothesis that in some way the distribution of the field was altered with each variation of the position of the brushes in such manner as to give a fairly good commutation at the changed positions. I confess that this hypothesis is no satisfactory explanation, and regret that I did not have the time or opportunity to study the peculiarity sufficiently to discover its true cause.

Elihu Thomson.

BUSINESS NOTICES, &c.

Accumulators.—Messrs. Conze & Simon have taken over the agency for the United Kingdom and the Colonies for the Cologne Accumulator Works, and are able to furnish price lists and particulars on application. We understand that the accumulators turned out by this company have been used for many years in different parts of the Continent for lighting, power, and traction work.

Burne Jones v. New & Mayne.—Sir E. Burne Jones, the artist, through Mr. Renshaw, Q.C., on Friday in last week, applied to Mr. Justice Kekewich, sitting in the Chancery Division of Justice, in the matter of an action he had brought against the New and Mayne Company, an electrical undertaking. Notice had been given them of an intention to ask His Lordship for an injunction to restrain them from working electrical machinery at Rottingdean, Sussex, in such a way as to cause a nuisance to the plaintiff by noise, vibration, and smoke. The defendants had, however, submitted to a perpetual injunction in the terms of the motion, and to pay the costs, the operation of the injunction being suspended, so as to permit the defendants to carry out alterations for the abatement of what was complained of. His Lordship assented.

Bankruptcy Proceedings.—Upon the petition of a creditor, dated 3rd ult., a receiving order was granted in the Wandsworth Court on 31st ult., in the case of Walter Raynes Smith, electrical engineer, of St. Andries, Hetherfield Road, Streatham, Surrey.

At the London Bankruptcy Court, last Tuesday, Mr. Registrar Linklater approved a scheme of arrangement entertained by the creditors under the failure of Joseph Torr Todman, to which we have repeatedly referred. The scheme provides for the payment of a composition of 7s. 6d. in the pound, by three equal instalments, extending over nine months from the present time. The debtor failed last January, and filed accounts showing total liabilities of £1,850 10s. 2d., of which £725 3s. 10d. is expected to rank against assets £207.

Catalogue.—A new catalogue of incandescent lamps, sockets, lampholders, switches, shades, carbons, and other accessories has been issued by Messrs. G. Straus & Co., Limited. Of the lamps included in the list, the candle powers range from $\frac{1}{4}$ to 1,800, the voltage from 1 to 280, and the watts from $1\frac{1}{2}$ to $3\frac{1}{2}$ per candle power. There are classified long life lamps ($3\frac{1}{2}$ watts) and high efficiency $2\frac{1}{2}$ and $1\frac{1}{2}$ watt lamps, low candle power or battery lamps for small accumulators for decorative, dental, surgical, and microscopic purposes, also high voltage lamps from 8 C.P. upwards. There are also fancy tubular, olive, crinkled, grooved, festoon, filigree, conical, Spirola, candle-flame, flat, switch, and focus lamps.

Exhibition.—The annual exhibition of scientific and natural objects, belonging to the Windsor and Eton Scientific Society, was held on 31st ult. at Windsor. Among the objects shown were Edison's latest inventions, the kinetoscope and kinetophone. Messrs. Harvey & Peake exhibited a number of interesting electrical instruments. The Windsor Electrical Company placed an oil engine in the hall, by which heating, cooking, and lighting, &c., by electricity were exemplified.

"Gas and Electric Lighting Companies' Directory and Statistics—1895."—London: Hazell, Watson & Viney. This year a radical change has been made in the arrangement of this annual publication. The tabular form of statistics has been replaced by the far more clear and convenient paragraph form of arrangement, and the directory can be had either separately or bound up with the "Water Companies' Directory." A review of the leading events of the year in relation to the progress of electric lighting is given in the introduction, special attention being given to the matter of explosions in transformer chambers. The value of the statistics relating to electric light undertakings is reduced by the somewhat curious—and often inaccurate—statements. We think, however, that these are due to want of revision.

Liquidation Notices. — At Shirehall, Worcester, at 11 a.m., on November 20th, J. Millington, J. Duce, J. H. Martin, R. J. Surman, and W. J. Hill will come up for public examination in connection with the liquidation of the New British Electrical Installation Contractors, Limited, of The Avenue, Cross, Worcester, whose failure we have several times referred to in these columns.

In the matter of the liquidation of the Cadogan Electric Light Company, Limited, a general meeting of the members of the company is to be held on December 16th, at 12 o'clock noon, at the offices of Messrs. W. B. Peat & Co., 3, Lothbury, London, to receive an account of the winding-up and the disposal of the property.

We understand that Messrs. J. C. Howell, Limited, of London and Llanelly, have resolved to wind up voluntarily. This step has been taken in order to effect a dissolution of partnership between the two managing directors, Mr. J. C. Howell and Mr. Wm. Meredith, in consequence of which Mr. Meredith retires from any share in the management of the business. The assets of the old company will be taken over by a new company of the same name, and the usual business will be continued without any interruption on precisely the same lines as hitherto. The liabilities of the old company will be discharged by the liquidator, Mr. S. F. Isitt, of 6, Old Jewry, London, E.C., in due course.

A general meeting of shareholders in the Swan United Electric Light Company, Limited, will be held at 36 and 37, Queen Street, Cheapside, on December 17th, at one p.m., to receive an account by the liquidator (Mr. H. C. Gover), showing the manner in which the winding-up has been conducted, &c.

Price List.—An illustrated price list of direct-current dynamos, motors, and motor-transformers has been sent to us by Mr. W. Mackie.

Presentation.—An interesting little ceremony took place at Messrs. Crompton & Co.'s Lillie Road Works on October 31st, when the employés presented Mr. D. Heap with a handsome set of carvers, on his vacating the position of works manager to take up another appointment.

The Ross-Hepworth Projection Arc Lamp.—With reference to this lamp, which was described in our last issue, Mr. A. J. Beaumont, of York, writes stating that "Mr. Hepworth's idea is not a novelty, as I have manufactured and placed upon the market a very similar article for about 12 months." Mr. Beaumont has sent us a circular showing the details of his lamp; but from these it appears that while both have a very similar hand-feed arrangement, there is a good deal of difference in other details.

ELECTRIC LIGHTING NOTES.

Asylum Lighting.—It is proposed to light the County Asylum, at Cheddleton, by electricity, special plant to be laid down in the engine room, but nothing has yet been definitely settled.

Bangor.—Mr. Medhurst wrote to the Mayor a few days ago, urging on the Council in regard to the electric lighting works if they wanted them in operation by the end of 1896. In consequence the Council, on 1st inst., instructed him to prepare the necessary plans and specifications.

Bristol.—The Electrical Committee has decided to make an all-round charge for the supply of electricity to motors at 4d. per unit, instead of 6d., as heretofore. Owing to the large demand for light, it has been found necessary to construct an additional transformer chamber.

Brierley Hill.—The Parish Council has decided to obtain information from two electric light companies with respect to the cost of laying down electric lighting plant.

Brighton.—From statements made at the last Town Council meeting, it appears that the electricity supply undertaking is working at a profit sufficient to keep the rate down one penny, *i.e.*, 1s. 7d. instead of 1s. 8d., which it would have been, had it not been for the electric light profit.

Belfast.—Prof. Kennedy is to represent the Council at the forthcoming Board of Trade Conference, to which we refer elsewhere.

Cardiff.—The forthcoming Cardiff Exhibition is expected to require about 1,200 15-C.P. incandescent and 200 arc lamps, and the question now being considered is, whether it will not be better to lay down a special plant than to take the supply from the Corporation mains. If the latter were done, it would necessitate extra plant being put down at the central station. A sub-committee has been formed from the Corporation Electricity and the Exhibition Machinery Committees to consider the question.

Car Lighting.—In the Hampstead procession on November 5th, the ten cars of the Queen's Crescent Bonfire Club were illuminated with electric lights by Peto & Radford, of Hatton Garden, 50 accumulators of 70 ampère hours capacity each, and 80 lamps of 10 volts each, being used. In spite of the heavy rain, the effect of the lighting was very successful.

Chagford.—With reference to the report of the meeting of the Chagford and Devon Electric Light Company, which appeared in our last issue, we now learn from the *Devon and Exeter Daily Gazette* that the local authorities have resolved to discontinue the electric lighting of the streets, and have accepted an offer to light them with incandescent gas for the 12 months ensuing.

Clerkenwell.—The Works Committee has reported to the Vestry that the County of London Electric Lighting Company, Limited, applied for permission to drain their transformer chambers into the nearest gullies, but that they had refused the application, and informed the company that the drains must be carried into the sewers in the ordinary way.

Dover.—Snargate Street will be lighted by electricity in a day or two.

Dutch East Indies.—Concessions have lately been granted for the electric lighting of Bandong, Soekaboemie, Poerworedje, Padang, Magelang, Soerakarta, and Djokjakarta.

Edinburgh.—The *Glasgow Herald* says that some interesting tests have been made at the electric lighting station by Prof. Kennedy, of London, and these, with others, will be embodied in the proceedings of the Institution of Mechanical Engineers. They refer to the efficiency of the plant, and particularly the economy resulting from the superheating of steam by the waste gases on their way from the boilers to the chimney stack, a point of great engineering interest at the present time. The steam pressure was 142 lbs. per square inch, and the steam was superheated to the extent of 10° at the boiler, while the temperature of the waste gases decreased from 738° to 584°, so that in the process of superheating the fall was 154°. The evaporation was 9·1 lbs. of water per pound of coal consumed, and the cost of coal was 7s. per ton. The rate of combustion was 55·8 lbs. of coal per square foot of grate area. As to the actual cost of generating the electricity, the mean cost, taken at the terminals, is about ·9d. per unit generated, rather less than 1d. Of this ·27d., or ¼d., is taken up by salaries, ·313d. for wages, ·319d. for fuel, ·026d. for stores, ·304d. for water, ·088d. for repairs and carbons. As there was only about 10 per cent. loss in the efficiency of the plant, the cost of each unit sold to the consumer works out at 1·09d., which is regarded as very satisfactory. Depreciation, percentage on cost of plant, rates and taxes, have, of course, to be added, and these add materially to the selling price.

The Caledonian Railway Company, it is understood, owing to complaints from the inhabitants in the vicinity of their Morrison Street Depôt, Edinburgh, regarding the spray from the Lucigen lights, have decided to remove them and substitute the electric light. The company, at the same time, has decided to light their goods yard at Lothian Road with electricity.

Fulham.—The Vestry invited three electrical engineers to attend before them the other day, and two put in an appearance, but as only six members of the committee were present, they were asked to come again yesterday evening. There is to be a special vestry meeting on the 27th inst. to consider the question of applying for a provisional order.

Hospital Lighting.—The committee of the Cancer Hospital, Brompton, have decided to introduce the electric light throughout the hospital premises, and have instructed Mr. Morgan Williams, C.E., to prepare specifications for the work.

Huyton-with-Roby.—The District Council has resolved to oppose any outside application for a provisional order.

Islington.—An Upper Street resident has served the Vestry with a writ and claims compensation for damage occasioned by the alleged negligence of the Vestry's workmen in laying the conduits and mains.

London County Council and Electric Lighting.—The Council, on Tuesday, sanctioned the laying of new mains by the Hampstead Vestry, the London and Brush Provincial Electric Lighting Company, the House-to-House, the St. James's and Pall Mall, and the Kensington and Knightsbridge Companies, and by the St. Pancras Vestry.

Manchester.—The City Council intends to apply for a provisional order for electric lighting extensions, and all the streets within the city boundaries are to be included.

Newport.—The Intermediate and Technical Schools are to be lighted electrically.

Cheltenham.—An employee at the electric lighting station was injured while unloading some transformers from a waggon. His leg was broken just above the ankle, and he was conveyed to the hospital.

Peterborough.—Dr. Fleming recommended recently that £20,000 be borrowed for electric lighting works, and the Council have the matter under consideration.

Rathmines.—The Rathmines and Rathgar Improvement Commissioners are to apply for a provisional order.

Reigate.—It is stated that Mr. F. H. Medhurst has been appointed by the Corporation to design and carry out a scheme to light the borough with electricity.

South Africa.—We cull the following notes from the *British and South African Export Gazette*:—An estimate has been prepared by the manager of the Sanitary Board for a new plant for the arc lighting of Johannesburg, and the order has been given out for a plant to supply 50 arc lamps. Mr. J. Hubert Davies has received the contract for the other portion of the electric lighting plant.—Messrs. Edlin & Stevenson, Cape Town, have fitted the new Royal Hotel in that town with the electric light and electric bells.—Orders may be expected for the installation of the electric light into the new buildings to be erected by the Argus Printing Company at Cape Town.—The contract for the electrical plant for lighting Buluwayo has been secured by the General Electric Company, of the United States. The current will be supplied by two single-phase high periodicity alternating dynamos of "General Electric" type. —We understand that the Durban Town Council has ordered in England the necessary plant for the additional lighting in connection with the utilisation of the spare power of the Council's electrical works.—We understand that Messrs. McIntosh & Seymour, Auburn, New York, have received the order from the General Electric Company, of the United States, for the two engines which are to drive the dynamos for the electric lighting of Buluwayo.—Messrs. E. R. and F. Turner, Ipswich, are supplying a 10 inches × 20 inches engine and boiler to a Witwatersrand company for electric lighting purposes.

Japan.—Plans are being prepared for the establishment of a plant for the utilisation of the Fall of Nachi in the generation of electrical energy for lighting purposes at Osaka.

Stafford.—The mains are to be extended along Lichfield Road at a cost of about £250, several residents having expressed the desire to have it in their premises. A recommendation having been made that arc lamps be erected in certain streets, the matter has been referred to the Electric Lighting Committee.

Wakefield.—The new Workhouse Infirmary is to be lighted by electricity.

Wimbledon.—Last Friday a prolonged Local Government Board inquiry was held at Wimbledon into the application of the District Council to borrow £32,000 for the purposes of lighting the town by electricity. Evidence in support of the scheme was given by Mr. A. Holland (chairman of the council), Mr. A. Preece, the framer of the scheme, Mr. W. H. Preece, and others. The feeling of many ratepayers present was that the scheme had been "rushed," and had not received proper consideration. In reply to Mr. Fletcher Moulton, Mr. Cooke (chairman of the Ratepayers' Association), admitted, amid uproar, that the local gas company had contributed towards defraying the expense of the association's counsel in opposing the scheme. Several ratepayers present demanded a poll of the parish on the matter, which the council declined to concede.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

American Railways and Electricity.—The *Financial News* says: "With the settlement of the lake front controversy in Chicago, the Illinois Central Railroad is ready to take up the matter of changing the motive power of its suburban service from steam to electricity. John Dunn, assistant to President Fish, says that within the next few months all the suburban trains, both local and express, will be run by electricity."

Brighton and Rottingdean Seashore Electric Tramway.—At a meeting of the Brighton Town Council last week a resolution was proposed to the effect that the application of the above company for permission to erect 13 tubular steel poles 80 yards apart on the foreshore between Paston Place Jetty and the borough boundary at Black Rock, for the purpose of carrying the electric trolley line, be granted, provided the company pay a rental of £1 per annum and enter into a covenant to remove the poles on receiving three months' notice. It was contended that the railway would be of the utmost benefit to the town. An objection was raised that the present scheme is a complete departure on the part of the company from the old scheme that was partially assented to by the Town Council. An amendment was moved adding to the resolution the following:—"Provided that the sum of £1,000 is deposited by the company with the Corporation by way of security for the removal of the tramway in the event of its being abandoned at any time hereafter, and that the details as to the application of such security be embodied in an agreement to be approved by the Works Committee." After a long discussion the amendment and resolution were withdrawn upon the understanding that the matter would be further considered about a fortnight after the municipal elections had taken place, and that the company be invited to instruct their engineer to attend.

Bristol Tramway Extension.—The work of constructing an extension of the electrical tramline to the top of Warmley Hill from the Kingswood terminus is now in full swing, as many as 100 men being employed. For the greater part of the distance the line is single.

Birmingham and Electric Tramways.—The proposal to adopt overhead electric traction on the Nechells-Duddeston section was the subject considered by a meeting of ratepayers last Monday.

Cable v. Electric Traction at Edinburgh.—At the last Council meeting, on the Lord Provost's Committee recommending, under recommit, the cabling of various lines in the city, the Lord Provost pointed out that the step here implied was a very important one. In order that afterwards there might be no misgiving on the matter, he would like to say that whilst they had had numerous letters suggesting electric motor power, they had never been approached by electric engineers on the matter. That, he took it, showed that electricity was not regarded as a suitable motive power for Edinburgh. He did not think the city would stand a system of overhead wires like clothes-lines all over the city. To the best of their knowledge, the cabling system was the most suitable.

Electric Traction in France.—Plans are being prepared for several lines of electric tramway at Cannes. It is also proposed to construct four lines of electric tramway in the town of Perigueux (Dordogne). It has been decided to construct an electric tramway in the town of Tourcoing (Nord.)

Electric Traction in Germany.—It has been decided to adopt electric traction on the tramways in the town of Brunswick.

Electric Traction at Leeds.—We hear that Dr. John Hopkinson is to prepare a report for the Corporation upon the proposed adoption of electric traction for the city.

Electric Traction in Austria and Hungary.—The question of electric traction is receiving consideration at Szekesfehervar. It is also proposed to construct an electric tramway in the town of Nagyvarad. It has been decided to extend the electric tramway at present in course of construction between Fiume and Abbazia, as far as Lovrano. A Vienna firm has prepared plans for an electric tramway in the town of Pecs. The International Electric Company, of Vienna, has secured a concession for the construction and operation of several lines of electric tramways in Teplitz.

Electric Traction likely at Gloucester.—At the last meeting of the City Council, it was stated that at a special meeting on 12th inst. a scheme for the electric lighting of the city, and the employment of electricity for the tramcars, would probably be brought forward.

Electric Tramways at Llandudno.—At a meeting of shareholders in the Great Orme's Head Marine Drive Company, it was resolved to sell the company's rights in the Marine Drive to the Manchester Edison-Swan Company at a price agreed upon, for the purpose of laying an electric tramway round the Great Orme, on the road hitherto used as a carriage drive.

Proposed Tramway at Herne Bay.—There is a proposal before the town to construct a deep sea pier and an electric tramway, the cost being estimated at £40,000.

Swansea Tramways.—The Corporation has the question of purchasing the tramways before it, one very important point which is receiving consideration being the use of electricity. The Tramway Committee report, which was presented to the Corporation on Wednesday, recommended the purchase, the lines to be prepared for electric traction.

Tramway for Vauxhall Bridge.—The Parliamentary Committee of the London County Council has reported recommending the Council to obtain powers to construct a tramway over the new Vauxhall Bridge. Here is an opportunity for the Council to adopt electric traction!

TELEGRAPH AND TELEPHONE NOTES.

Telephonic Communication in the Dutch East Indies.—A concession has lately been granted for the establishment and operation of an interurban telephone line between Batavia, Semerang, and Soerabaja.

Telegraphic Communication between Bulgaria and Russia.—It is reported that negotiations are well in hand between the Bulgarian and Russian Governments for the establishment of submarine telegraphic communication between Odessa and Varna.

Telephonic Communication in Madagascar.—Telephonic communication between Tamatave and Antananarivo was established on the 1st inst.

Trinidad Island.—With reference to the correspondence and editorial comments which have been appearing in the *Daily News*, and also to the comments of Sir John Pender, reported by us last week, regarding the question of the use of this island, Mr. R. M. Cunningham, the secretary of the Western and Brazilian Telegraph Company, writes to the *Daily News* stating that for whatever period differences may have existed between the Brazilian Government and the Brazilian Submarine Telegraph Company, they are in no way attributable to any action of the Western and Brazilian Company, which has always desired, and has always striven to maintain the most friendly relations with the Brazilian Submarine Telegraph Company. "As respects the present tension, however, between the Government and the company, that report of the Director-General of the Government Telegraphs will speak for itself."

CONTRACTS OPEN AND CLOSED.

OPEN.

Blackburn.—November 30th. The Corporation invite tenders for alternators, transformers, switchboards, &c. Details to be found in our "Official Notices."

Derby.—November 12th. Tenders are invited for the wiring, fittings, &c., for the completed portion of the Municipal Technical College, Green Hill, Derby, for the Corporation. Particulars from Mr. J. E. Stewart, engineer, Electric Lighting Station, Derby.

Fermoy.—The Town Commissioners are inviting tenders and schemes for electric lighting the town (public and private.) Further details will be found in our "Official Notices."

Germany.—November 15th. Tenders are being invited by the State Railway Telegraph Department at Saarbrücken, Germany, for the supply of 1,500 telegraph poles. Tenders to above address.

Italy.—Tenders are, it is reported, at present being invited by the Municipal Authorities of Ceoa (Mondoir-Cuneo) for the electric lighting of the town.

London.—November 18th. From our Official Notices will be gathered information regarding tenders invited by the Metropolitan Asylums Board for wiring and other electric light work at the Brook Hospital and Ambulance Station, Shooter's Hill. This matter is also referred to under "Electric Lighting Notes."

Madrid.—November 15th. The Director of Public Works is inviting tenders for the concessions of the construction and working of a tramway from Madrid to Colmevar Viejo, with branches to Chamartin and Rosa. Security 12,505 pesetas. Particulars at the Direccion General de Obras Publicas (Ministerio de Fomento), Madrid.

Nottingham.—November 9th. Tenders are invited for supplying a Lancashire steel boiler, 26 feet long and 7 feet diameter, for the Corporation. Particulars of Mr. Arthur Brown, M.I.C.E., borough engineer, Guildhall, Nottingham.

Chili.—December 5th. Tenders are invited for the manufacture and laying of a submarine telegraph cable from Puerto Montt to Punta Arenas. The conditions and specifications may be consulted in the Chilian Legation, Member's Mansions, 36, Victoria Street, S.W.

Vienna.—November 14th. The Municipality of Vienna asks for tenders and plans for the construction and working of electric railways in and around the city. The notice may be seen at the Commercial Department of the Foreign Office.

CLOSED.

Aberdeen.—Tenders for the electric wiring of the Library building have been opened and the offer of Messrs. Shirras, Laing and Co., Aberdeen, accepted.

Blackburn.—From the tenders sent in for electric light cables for the Council that of Messrs. W. T. Glover & Co., at £1,800 has been selected and accepted.

Edinburgh.—The following is a list of the tenders sent in for wiring the Waverley Market for electric lighting for the Lord Provost, Magistrates and Council of Edinburgh, Mr. E. W. Monkhouse being the Council's resident engineer:—

	£	s.	d.
Claud Hamilton, Limited, Glasgow	854	0	0
Wm. Bryden & Son, Edinburgh	614	14	0
Cameron and Hogg, Edinburgh	623	2	6
King & Co., Leith	906	0	0
Anderson & Munro, Edinburgh	640	10	0
Lowdon Bros., Dundee	745	0	0
Haddow & Co., Glasgow	710	14	0
Brush Electrical Engineering Company, Edinburgh	720	15	0
H. Binko & Co., London	734	0	0
James Milne & Son, Limited, Edinburgh (accepted)	459	5	0
W. Mackie, London	991	4	0
Matthew Buchan, Portobello	800	0	0
V. G. Middleton, London	710	10	0
Ernest Scott & Mountain, Newcastle-on-Tyne	605	0	0
H. F. Joel & Co., Edinburgh	656	12	0
Paterson & Cooper, Glasgow	677	10	0

London.—The tender of Messrs. Morris & Son (£59 10s.) has been accepted by the St. Saviour's Guardians, for wiring and fitting the Board room and offices for electric lighting.

NOTES.

Competition v. Under-Cutting.—One of the most unhealthy elements in the electrical trade is the under-cutting of prices, to which we have referred over and over again. That some joint action on the part of contractors is considered advisable to overcome the evil will have been gathered from our frequent references to special instances, and from the correspondence on "Unwarrantable Competition in Electric Wiring," which has been running in our columns during the past few weeks. The wiring and fitting branches of the trade are undoubtedly the chief offenders, and the only redeeming feature is that a desire exists among certain firms to consider the question of adopting remedial measures. Difficulties might, and probably would, arise in such negotiations, but we think it would be an advantage if the contractors interested could meet together and arrive at some arrangement similar to that made by the cable manufacturing companies, who, following the lead of the Silvertown Company, are circularising the trade to the effect that they are advancing their prices for electric light and power wires and cables 10 per cent. They have been forced to make these advances on account of higher prices having to be paid for raw material. The companies are to be congratulated upon the step they have taken, for when a mutual arrangement can be and is made to prevent throat-cutting competition, it is the wisest course that could be adopted, and is also a very healthy trade sign, although, viewed in another light, advanced prices might be regarded differently, and with a certain amount of misgiving. Mutual arrangements such as this are excellent so long as they do not lead to raising prices unnecessarily, but there is no likelihood of our cable firms doing such a thing. Some of the dynamo makers, we believe, had previously forestalled the wire makers, inasmuch as several raised their prices some weeks ago. The rise in the price of cables must affect the estimates of wiring and fitting firms to a certain extent, and it has been suggested to us that the present might be a fitting opportunity for contractors to come to a general understanding to raise prices to an extent sufficient to ensure good work and still leave them a margin of profit. We are prepared to publish further correspondence regarding this important subject, and hope some really practical action will be the outcome.

Niagara—Buffalo Transmission Scheme.—We have already referred to the controversy in the American Press as to the commercial success likely to attend the scheme for the transmission of power from Niagara to Buffalo. Several of the New York technical journals have not hesitated to affirm that they consider the scheme will be a failure, as power transmitted from Niagara could not be supplied so cheaply as steam-power generated on the spot. The Niagara Company, when asked to fix a charge for its power, refused to state a limiting price. *Electric Power* affirms that it would have been most difficult, if not impossible, for the company to know what to allow for losses in transmission, and what local circumstances would have to be taken into consideration. *Electricity* (N.Y.) says that at that time the company refused to quote for Buffalo, it had contracted with another consumer for 1,000 electrical H.P. at $20 per H.P. per annum, the distance over which it was to be transmitted being about one mile. Our contemporary upon this makes a calculation that to deliver at Buffalo City line the cost will be $48 per H.P., and adds the following :—

But when we consider that the power when delivered at Buffalo is not yet in an available form, but must be transformed down, and when distributed in this transformed state is still not in an available form for the customer, but requires an additional investment on his part in the way of further transformers, motors, and wiring, making an investment nearly, or quite, equal to that of a steam plant, it is not clear how either the Niagara Company or the City of Buffalo could afford to sell power even on a 24-hour basis in competition with steam. But when we consider 10-hour power, such competition would seem to be entirely out of the question. It must be remembered that by far the largest number of power consumers use it not more than 10 or 12 hours a day, and that absolutely none of them ever use it 24 hours a day for 365 days in the year. The Niagara Company's figures have thus far been exclusively on a 24-hour and 365-day basis, so that no matter what figures they have given, or may give, they are meaningless on a horse-power-hour basis, because it will never be used to the limit. It is not, therefore, that the engineers who have condemned the Niagara scheme are thoughtless, as *Electric Power* suggests, but that those who have accepted it as a commercial project are thoughtless, or worse.

Electric Railways and Launches in the States.—In an illustrated article in the New York *Electrical Engineer* the progress being made in electric launches in the States is recorded, with special reference to their use in conjunction with electric railways. Our contemporary says that so far the variety of private electric launches has not been large, the 1894-95 tendency being to build large boats for wealthy people. The trolley roads are found to be the best customers for electric launches, and the companies are finding in them a remarkably good source of income and profit. Passengers are willing to pay higher fares in electric launches than on railways, while at the same time the average depreciation on boats and batteries is stated as below that of an ordinary car, and the expenses of operation are strikingly small. Our contemporary thinks there is every promise that 1896 will be by far the best year that electrical navigation has seen in America. The Milwaukee Street Railway system runs in connection therewith a service of five electric launches, each 30 feet long, for 35 passengers, on the Wisconsin River, and it proves a very profitable investment. The manager of the service is satisfied that for short passenger service on lakes and rivers the electric launch will, as soon as confidence is put in it, replace the steam craft entirely. The following instances are also quoted by the *Electrical Engineer*:—Four launches running on Ludlow Lagoon and Jamaica Pond. Batteries charged from the Cincinnati Trolley lines. Each boat is fitted with 66 batteries charged in series with current of 15 to 20 ampères and about 145 volts per boat; three boats in series taking 435 volts off the 500 volt trolley circuit. Five launches (from the World's Fair) running at South Park, Chicago, for passenger and excursion service. Two launches running on the Jamaica Pond in connection with the Boston Public Park Boat service. Each boat is fitted with 52 batteries, 200 ampère hours each, and charged from the trolley lines of the West End Railway. The charging current is taken from underground mains, and the surplus E.M.F. is taken up by a water resistance. One launch on Lakemont Park, Altoona, Pa., run by the Altoona and Logan Valley Electric Railway Company. Batteries charged from the trolley circuits. One launch on Lake Saltonstall, near New Haven, Conn., charged with current from the trolley line, taking 18 ampères; she has 64 batteries. Six launches on the ornamental lake at the Atalanta Exposition, where a separate charging station has been fitted up. Each boat has 56 chloride batteries 175 ampère hours each; charging done from an 85 volt constant potential circuit fed by a generator in the Machinery Hall. Average charge from 35 to 40 ampères. We also understand that several trolley roads and parks, large hotels, &c., are already making their plans for electric launch services for 1896, and in these instances it is expected a smaller type of boat will be adopted.

Brazil as a Field for Electrical Engineers.—Some time ago, we recommended manufacturers and contractors to give greater attention to their trade with certain foreign countries, including Brazil. That there is a promising field, will be gathered from the following comments of the *British Trade Journal* correspondent located at Rio de Janeiro. He says:—

> In my former letter I stated that there was a good opening in Brazil at present for electrical engineers, especially for the establishment of electric light plant. Among the towns which have recently adopted the electric light are Sao Carlos do Pinhal, Casa Branca, Jacarehy, Rio Claro (all in the State of Sao Paulo); Santa Rita do Passa Quatro (State of Minas Geraes); and Petropolis (State of Rio de Janeiro); while in Bragança, Mogymirim, Ribeirao Preto, Amparo, and Santos (all in the State of Sao Paulo), the erection of the necessary plant is either in progress or under consideration. For electric tramways there also seems to be a good opening. One of these has been in operation in the City of Rio de Janeiro for some years past, with the best results. The electric tramway is laid along a level road between the centre of the city and the most fashionable suburbs, but in the immediate neighbourhood of the business part of the city there are numerous steep hills, up which no ordinary vehicle can ascend. These seem to be specially adapted for the use of cable cars.

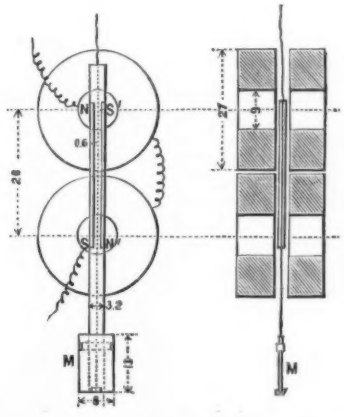
The Series-Parallel Controller.—A "Student," referring to the combinations effected by the series-parallel controller, which is shown in our article on the Bristol Tramways on October 11th, asks if they are correct, and if the shunt forms a shunt to the series. The diagram is perfectly correct; when the controller handle is on the last notch (maximum speed), a shunt is put across the field of each motor.

The "Porous-Planté" Storage Battery.—In a recent issue of the New York *Electrical Engineer* is a description of the "Porous-Planté" battery, so named on account of its peculiar structure, which has been devised by Mr. J. Hart Robertson. The cell is after the style of the original Planté type of cell. The plates are not made porous by pressing a number of particles together, but each consists of one continuous mass of lead with a sponge-like formation which gives a very large surface whether the plate be thick or thin. The active material that is formed from the lead by electrolytic action is held securely in the innumerable irregularly shaped cells and corrugations throughout the body of the plate. Our contemporary gives the following method of manufacture:—

> Pumicestone is used in a granulated state, and is mixed with lead when the same is in a pasty condition, and kept in that condition, by proper heat regulators, until the mass is well kneaded, when it is pressed into a mould of the required shape, and left for a minute to cool. In the act of mixing, the heat expands the air in the pores of the pumicestone, which expansion causes a multitude of cells to form throughout the lead. An examination of a section of a plate with a microscope shows that for every particle of pumicestone seen, there are hundreds of thousands of minute cells formed by the tendency of the heated air to force its way out. The porosity of these plates is such that a plate 9 by 7½ inches will hold about 5½ ounces of water.
>
> The particles of pumicestone can be eaten out of the lead by a simple process, if desired, but as there is only 10 per cent of solid matter in it, and being electrically inert, it makes no difference whether it is left in or taken out. It is obvious that this method allows of great variations in the porosity, and therefore in the weight of the plates, but it is found that 50 per cent., in bulk, of pumicestone (the weight of the pumicestone is practically nothing) is a fair average amount to use.

The objection to all porous plates is that although they have a comparatively high capacity and work satisfactorily when new, the progressing oxidation disintegrates the plates after some time. If such were the case with plates that had no foreign body imbedded in them the risk with the Robertson plate must be greater, as the particles of pumicestone imbedded in the plate must have a weakening effect, which will be the greater in proportion as the plate is thinner. To eat the particles of pumicestone out of the lead might not prove such a simple process as the writer in the *Electrical Engineer* anticipates.

A New Arrangement of Galvanometer Needles.—Mr. P. Weiss, in a recent issue of *Revue d'Electricité*, describes a novel arrangement of the needles in a Kelvin galvanometer, which is stated to give excellent results, and is worthy of notice. The arrangement will be at once understood from



the diagrams. Instead of the short horizontal needles usually employed, long vertical ones are substituted; these needles are fixed on a strip of mica. There are several advantages in the use of long needles, as compared with short ones, which must be evident, and which make Mr. Weiss's idea a good one.

The Board of Trade and Light Railways.—The Board of Trade is not losing sight of the light railways question, for Mr. C. T. Ritchie, the president, Sir Courtenay Boyle, and the Earl of Dudley, are at present making a tour of inspection of the various light railways in Belgium. They were present at a dinner given in their honour at Brussels a few days since by the Belgian National Society of Light Railways.

Firing Boilers with Mixed Coal.—Some weeks since a correspondent of the *Scientific American* made a claim for economy in firing boilers with a mixed fuel consisting largely of hard coal screenings. In a more recent issue another correspondent severely criticises the claim, which appears to have been a case of reasoning from the particular to the general, and goes on to show that from the writer's own statements the superior results he obtained are already sufficiently accounted for by other things, one of which was more boiler capacity, another less price for the coal. We are not here concerned with this controversy, but may however point out the mistake made in basing estimates or conclusions upon special results that perhaps cannot be reproduced. Thus an attempt was once made to burn hard coal screenings in Minneapolis, the stuff coming from Duluth, but it was soon found that the supply of this fuel was altogether too small, and insufficient all told to keep going a plant of 3,000 horse-power. The mere fact of finding an improvement to arise from a mixture of fuel is nothing very surprising. One mixture may often give better effect than another, and it is possible that the special mixture mentioned containing a considerable amount of hard anthracite would be of assistance in reducing the formation of soot, and so would clean the plates of a boiler and increase the efficiency. If a special fuel or mixture is found suitable for a particular boiler, it should be adhered to as much as possible because its behaviour is familiar to the stokers, and they acquire special skill in its use and can obtain better results than where they are always being supplied with fuel that is never the same for two weeks together. Every boiler has some particular fuel which is best suited to the particular duty and to the draught, and because a certain coal has proved good at one place it by no means follows it will be the best in any other case. There is always a tendency to exaggerate the effect of any special line of practice which has given good results, but too frequently the new practice has had the advantage of special care and as good results would follow equal care under the older conditions. It is because of the very serious effects of carelessness upon economy where solid fuel is employed that so much is to be hoped from gas producers, which cannot go far wrong so long as they are kept full of fuel. They are, in fact, creatures of design, independent of any special skill and as such will make headway.

Horseless Carriages and the Locomotive Acts.—The Farnham magistrates have interpreted the Locomotive Acts just as we should expect, and their view differs from that of the Mayor of Tunbridge Wells. Mr. Knight, a Barfield gentleman, was summoned before them on 31st ult. for allowing a locomotive (petroleum tricycle) to be at work in the public streets of Farnham without a license, and his employee was also summoned for working the same during prohibited hours. They were each fined 2s. 6d. and 12s. 6d. costs. The motor-carriage in question, which was drawn up outside the court while the hearing took place, was the object of eager scrutiny. The *Daily Telegraph* referring to the case, says that "the task of *getting up steam* occupied about ten minutes, and the tricycle in charge of two men moved off," &c., &c. A petroleum tricycle getting up steam is good.

Royal Institution.—The following have been elected members:—H.R.H. Prince Louis Philippe, Duc d'Orleans, Sir John Evans, K.C.B., F.R.S., the Hon. Adrian Verney Verney-Cave, Mr. Walter Allcroft and Mr. James Beale. The late Mr. John Bell Sedgwick, M.R.I., has bequeathed £300 to the Royal Institution in aid of the Fund for the Promotion of Experimental Research at Low Temperatures. Sir Frederick Abel, Bart., has also given a domation of £50 to the same fund.

Personal.—A dinner, to take place at the Holborn Restaurant on 14th inst., has been arranged to commemorate the fiftieth anniversary of Mr. W. T. Ansell's entrance into the telegraph service, of which he is now the doyen. The chair will be taken by Mr. J. Denison-Pender, the managing director of the Eastern Telegraph Company. It is also proposed to present Mr. Ansell with a suitable memento of the occasion.

The County Council's Latest.—A member of the London County Council has given notice of his intention to move that the Highways Committee consider and report, without delay, upon the expediency of the Council applying to Parliament for power for the Council and the local authorities to construct subways under the streets of London for the reception of the tubes, wires, &c., of the gas, water, electric lighting, and other companies, and to charge rent for the same. We can hardly think the councillor in question is serious, for the very idea is utterly absurd if a moment's thought is given to the existing state of the London subsoil and its network of tubing, &c. Of course, we do not expect a county councillor who takes it upon himself to propose such extreme measures to consider all the many intricate details. The immense cost alone would be quite prohibitive, and there is not a shadow of a doubt that the gas, electric lighting, water, and other companies interested, would fight most strenuously against anything of the kind if it involved any compulsory action on their part. The motion, as it stands, is extremely vague, so that it is impossible to know whether the councillor in question thinks the many thousands of miles of street mains should be taken up and relaid in his suggested subways, London, meanwhile, taking a long holiday, or whether he suggests them for new works that may be laid in the future. Many years ago, before there was any underground work of importance, such a suggestion might have been practicable, but in 1895 it is, on the face of it, impracticable and exceedingly ridiculous. We can hardly think the Council will award this gentleman the cheap notoriety he covets by troubling its Highways Committee with such a matter.

Institution of Electrical Engineers.—The Institution of Civil Engineers have kindly consented to permit the meetings of the Electrical Engineers to be held in the new building of the former Institution, but inasmuch as there is some doubt as to whether the building will be sufficiently advanced to permit of the use of its Lecture Hall on the 14th inst., the Council of the Institution of Electrical Engineers have decided to postpone the opening of their session until the 28th inst. The annual dinner of the Institution will take place at the Freemason's Tavern on Friday, November 29th.

Board of Trade and Electric Lighting Regulations.—On Tuesday, 19th inst., at 11 a.m., at 8, Richmond Terrace, there is to be a meeting convened by the Board of Trade, when it is proposed to discuss the various observations and suggestions which have been received by the Board with reference to the revised draft regulations which have been prepared by that Board under the Electric Lighting Acts for securing the safety of the public, and for ensuring a proper and efficient supply of electrical engergy.

Lectures.—A lecture on "Magnets and Electricity," was delivered at Portsmouth Town Hall by Prof. J. A. Fleming, on 24th ult.

At the Assembly Room, Ashford, Mr. A. P. Laurie, D.Sc., has been delivering a course of lectures on "Light and Colour," one of them treating of the generation of electric current for lighting.

Steering by Electricity.—It is stated that a series of experiments having been carried out with success in steering German warships by electricity, the new method is expected to be shortly adopted in the Imperial Navy. The ordinary steering gear will be retained for use in case of accident.

Electricity in Mining.—The proprietors of the Roros Copper Works have placed a contract with a Christiania firm for a large electrical plant, it being intended to light the mines, as also to operate the mining machinery, by electricity.

Accumulators in Germany.—It is stated that the Faure accumulator patent rights in Germany expire in February next. This will, it is expected, be the signal for keen competition in the accumulator trade in that country.

Professorship Vacant. — Prof. Mullineux Walmsley having accepted an appointment as principal of the Northampton Institute, Clerkenwell, London, the professorship of applied physics and electrical engineering at the Heriot-Watt College, Edinburgh, with a salary of £400 per annum, thus becomes vacant. Applications have to be lodged with the Treasurer at the College by November 22nd.

The "Autocar."—A new weekly journal with this title commenced publication on Saturday last. It is to run in the interests of the mechanically propelled road carriage.

NEW COMPANIES REGISTERED.

Automotive Syndicate, Limited (45,804).—This company was registered on October 29th with a capital of £5,000 in £1 shares, to carry on the business of makers of electric, steam, gas, oil, or other motors, general engineers, ironfounders, blacksmiths, and ironmongers. The subscribers (with one share each) are:—H. E. Preen, C.E., Basing House, E.C.; W. Trask, 16, Craven Street, Strand, gentleman; T. Charlick, C.A., Basing House, E.C.; M. H. Smith, 3, Whitehall Place, S.W., engineer; G. L. Lyons, 70, Cornhill, E.C., gentleman; F. Marshall, 3, Lincoln's Inn Fields, W.C., solicitor; G. A. Phillips, 70, Cornhill, E.C., stockbroker. The number of directors is not to be less than three nor more than five. The first are:—H. E. Preen, M. H. Smith, and G. L. Lyons. Qualification £50; remuneration £500 per annum, divisible, and a share in the profits. Registered by Marshall and Marshall, 3, Lincoln's Inn Fields, W.C.

Improved Electric Glow Lamp Syndicate, Limited (45,815).—This company was registered on October 30th with a capital of £5,000, in £1 shares, to acquire, develop, work, and turn to account a patent for "an improved form of globe for electric glow lamps," and to adopt a certain agreement. The subscribers (with one share each) are: M. W. Ash, Forest Road, Walthamstow, engineer; L. Steinberg, 113, Cambridge Road, N.E., clerk; W. F. Smith, 65, Warrer Road, Leyton, electrical engineer; G. W. Puttnam, 56, Mildmay Street, N., engineer; F. Leleux, Credit Lyonnaise, Lombard Street, E.C., clerk; H. Bilberg, 17, Princes Street, Cavendish Square, W.; E. H. Taylor, 29, Bedford Place, Bloomsbury, surveyor. The number of directors is not to be less than three, nor more than five; the subscribers are to appoint the first; qualification, 50 shares. Registered by Snell, Sons & Greenip, 1, George Street, Mansion House, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

General Traction Company, Limited (43,880).—This company's statutory return was filed on October 15th. The capital is £50,000 in £5 shares (5,000 preference). All the ordinary and 804 preference have been taken up, and all have been issued as paid.

Epstein Electric Accumulator Company, Limited (34,528).—This company's registered office was, by notice filed October 17th, removed to Victoria Mansions, 28, Victoria Street, Westminster, S.W.

Connolly Brothers, Limited, (44,277).—This company's statutory return was filed on October 12th. Seven shares have been taken up out of a capital of £20,000 in £5 shares, and £35 has been paid.

Electric Construction Company, Limited, (39,292).—This company's annual return was filed on October 15th. The capital is £400,000 in £2 shares (150,000 ordinary and 50,000 preference). 110,000 ordinary and 16,343 preference have been taken up, and all the ordinary and 13,145 preference are considered as paid. Full amount has been called on the rest of the preference, and £6,383 has been paid, leaving £13 in arrears.

CITY NOTES.

The Western and Brazilian Telegraph Company, Limited.

The report of the directors to be presented at the thirtieth ordinary general meeting of the company at Winchester House on the 14th inst., at 12 o'clock, states that the total earnings amount to £84,936 16s. 11d., as against £77,603 3s. 6d., an increase of £7,333 13s. 5d. compared with the half-year to June 30th, 1894. The working expenses amount to £37,891 9s. 6d., as against £37,953 0s. 2d., a decrease of £61 10s. 8d. Including the amount brought forward from 1894 (£2,846 1s. 9d.), the balance to the credit of the revenue account is £49,891 9s. 2d., from which has to be deducted £11,223 10s. for debenture interest, £7,876 10s. for the debenture redemption fund, £1,729 18s. for income-tax, and £5,000 placed to reserve fund. The directors now recommend the payment of a dividend, free of income tax, for the half-year, at the rate of £2 10s. per cent. per annum, as against £2 per cent. per annum for the corresponding period, carrying forward £5,803 7s. 5d. This dividend will be payable as follows, viz, 3s. 9d. per share to the ordinary shares, and 3s. 9d. per share to the preferred ordinary shares. The position of affairs between the Government of Brazil and the company, as to the acquisition of the cables, remains the same as at the date of the last general meeting. The Government, however, are taking authority to continue the authorisation for the purchase of the company's system. The shareholders are aware that the Amazon Telegraph Company, Limited, has recently been formed for the purpose of laying a system of cables up the river Amazon, and connecting many important places on that river with Para, the northern terminus of this company's system. The directors anticipate that when this line is opened, in or before March, 1896, it will prove a valuable feeder to this company. The directors have to notify that the conversion of ordinary shares into preferred ordinary and deferred ordinary shares will be suspended on and after January 1st, 1896, until further notice. The dividend warrants will be posted on the 15th inst.

The West India and Panama Telegraph Company, Limited.

The report of the directors and the accounts for the half-year ended June 30th, 1895, to be submitted to the thirty-seventh ordinary general meeting, November 13th, 1895, states that the amount to credit of revenue is £39,849 18s. 6d., against £40,598 1s. 2d. for the corresponding half-year of 1894, and the expenses have been £21,848 19s. 8d. against £24,488 17s. 5d., leaving a balance of £18,000 18s. 10d. which, with £710 1s. 7d. brought from last account, makes a total of £18,711 0s. 5d., with which it is proposed to deal as follows:—

	£	s.	d.
First preference shares—			
Dividend, 6 months to June 30th, 6s. per share	10,368	18	0
Second preference shares—			
Dividend, 6 months to June 30th, 6s. per share	1,400	14	0
Ordinary shares—			
1s. 3d. per share (free of income tax) ...	5,520	1	3
Balance to current half-year's account	1,421	7	2
	£18,711	0	5

The traffic receipts for the six months show a decrease of £241 18s. 4d., as compared with the corresponding period. The expenses of repairing cables during the half-year amounted to £8,849 5s. 11d., being £2,524 14s. 0d. less than those for the corresponding period. This decrease is due to the smaller quantity of cable used, and to the company's s.s. *Grappler* not having been occupied so many days in effecting repairs. The directors regret to announce the resignation by the Right Hon. G. W. Balfour, M.P., of his seat on the board of the company, on accepting the office of Chief Secretary to the Lord Lieutenant of Ireland. It is not proposed to fill up the vacancy at present. The *Grappler* came home in August last for the purpose of shipping a cargo of 203 knots of new cable and has since returned to the West Indies. The *Duchess of Marlborough* still continues to lie up in London, out of commission.

Woodhouse & Rawson United, Limited.

A meeting of the debenture-holders was held on Tuesday, at Cannon Street Hotel, E.C., under the presidency of Mr. C. J. Stewart (the Official Receiver).

The Chairman stated that the meeting had been called in consequence of an order of the Court, and following on the decision arrived at at a meeting on June 13th last. At that meeting it was decided by a majority of those present that the debenture-holders were averse to the funds realised in the debenture action being appropriated for the purpose of taking proceedings against the directors, auditors, and officers of the company under Section 10 of the Act. He might remind them that the application originally before the Court arose as the result of the public examination. Following on the public examination a case was prepared by the solicitors who were acting for the Official Receiver and liquidator, which was submitted to the solicitors representing the receiver, and the case was approved by them, and was submitted to counsel, who gave it as his opinion that proceedings would be successful with respect to dividends paid by the company during certain years. The matter came before Mr. Vaughan Williams, who had directed that two meetings of the debenture-holders should be held for the purpose of obtaining the votes of the debenture-holders for or against taking proceedings against the directors and auditors.

In reply to a Debenture-holder, the Chairman said that the debenture-holders who had sent in proxies against the proceedings, and who were willing to abandon their rights, numbered 16, and represented £8,826; and those proxies sent in against the proceedings, and who were not willing to abandon their rights, numbered 21, and represented £9,054; while the proxies sent in in favour of continuing the proceedings numbered 54, and represented £33,254.

The debenture-holders were asked to sign and hand in the voting papers, and the chairman stated that he would report the result to the Court.

Aluminium Company, Limited.

THE report of the directors for the 12 months ended June 30th, states that their forecast regarding the value of the new patents belonging to the company has been realised, and that the general business of the company at Oldbury continues satisfactory. The accounts show a gross profit of £16,901 for the financial year. After providing for debenture interest, amounting to £7,497, and other fixed charges, there remains a balance of £3,901, which, with the sum of £1,475 brought forward from last year, makes the sum of £5,376 available for distribution. Out of this the directors recommend the payment of a dividend of 5 per cent. for the year on the "A" shares, which will absorb £3,000, leaving a balance of £2,376 to be carried forward. The shareholders have been informed of the agreement entered into in January last with the Mathieson Alkali Company of America for the sale of the Electrolytic Alkali patents for the United States, and the directors have to report that the plant has been completed, and is now being put into operation. The company are to receive, upon the satisfactory running of the plant, the sum of £65,000, payable as to £30,000 in cash, and £35,000 in shares, besides substantial royalties calculated on the output, with a minimum sum guaranteed during the life of the patents. In October last an agreement was concluded with Messrs. Solvay & Cie., who are the owners of the Kellner Alkali patents, for a combination of both the Castner and Kellner patents, for the mutual advantage of the Aluminium Company and Messrs. Solvay & Cie. The Aluminium Company, under this arrangement, obtained the sole right to work the combined patents in England and the colonies, and Messrs. Solvay and Cie. the sole right to work the same patents on the Continent. The agreement also makes provision that both companies shall work in friendly alliance for at least 12 years, and the Aluminium Company receive a sum of £5,000 as an extra consideration for such agreement. This arrangement enabled the directors to sell the Castner patents with the benefits of the agreement with Messrs. Solvay & Cie (other than the right to receive the said sum of £5,000) to the Castner-Kellner Alkali Company, Limited, for the sum of £125,000, payable as to £25,000 in cash and as to £100,000 in shares. Some intimation was given to the shareholders at the last meeting as to another important chemical process invented by Mr. Castner. So successful has this last process proved to be, that an arrangement has been concluded between this company and one of the largest and most influential firms in Germany for the sale of the American patents, together with certain other manufacturing privileges. This company will receive the sum of £10,000 (£5,000 of which has already been paid) and 30 per cent. of the share capital of the American company now being formed, the capital of which has been guaranteed by the German firm. This leaves the Continental and British patents still to be disposed of, and as negotiations are pending for their sale, it is deemed advisable to make no further announcement. The directors consider that any depreciation on the patents and on the works at Oldbury is more than covered by the developments in respect of patents which stand on the books of the company at comparatively nominal figures. It is decided to pay off the £12,000 10 per cent. "B" debentures which fall due on January 1st, 1896. The directors are also making arrangements for reducing the present £6 per cent. debenture debt by paying off the present issue, and, if necessary, raising a much smaller loan at a lower rate of interest.

Elmore's Patent Copper Depositing Compauy, Limited.

THE annual meeting of Elmore's Patent Copper Depositing Company, Limited, was held last Friday at Leeds, Mr. John North presiding.

The CHAIRMAN, in moving the adoption of the report, said that the directors had been in office rather less than 12 months. Although they had not had at their disposal any other resources than those possessed by their predecessors, and notwithstanding that during the past year there had been a drop in the average price of their finished manufactures of over £12 per ton, they had been able to wipe out the old sources of loss which were so serious in the two preceding years, and to effect an actual net profit of £80 6s. 4d.—a profit which was even better than it looked upon paper. They had also had, as previously, to contend with determined competition, and the year had had to bear the burden of one or two low priced contracts which had not been executed at the time they took office. Explaining this improvement, he said that in the first place there had been a much larger turnover in the factory, without any corresponding increase in the expenses, and next they had effected considerable economies, and further, that Messrs. Elmore had, if possible, exceeded their former efforts in striving to lift the company out of its former difficulties. If they had been working all through the year to their full capacity they should have presented a very different account. As to the profit, he entered into a number of financial details, and said that there was really a net profit of £1,236 on the proper basis of the company's manufacturing operations. They had reached a point when it was practically impossible to do better than they had during the last six months, unless the company was furnished with adequate capital. The company had no difficulty in securing very remunerative orders, and they expected to be appointed on the list of contractors approved by the Admiralty, which would enormously increase the amount of business offered to them. They had already supplied tubes and cylinders to foreign navies, though they had not yet been directly appointed contractors to the British navy. The comments passed upon the copper condenser cylinders made for Russian boats built by Mr. Yarrow, by competent engineers, were very gratifying, and it was well to remember that these large cylinders could only be produced by the company's process. With regard to the method of raising further capital, it was proposed to extend the company's borrowing powers, as such a step would give them every power and facility that could be afforded by an increase in the share capital of the company, while it had the advantage of saving the expense of increasing the share capital, and possessed other advantages. They already had some substantial offers of assistance in the debenture issue; but in the first place the offer would be made to the shareholders, and the directors hoped they would respond now that the company had been brought through its difficulties and established upon a paying basis. With regard to the proposed reduction in the ordinary share capital, he thought it must be evident to all of them that that step was necessary, and that at the same time it inflicted no injury or loss upon anyone. The company's profits would be exactly the same whether the capital was reduced or not, and the dividend upon the reduced shares would, of course, be double the rate of the dividend paid upon the full amount of the scheme, so that the market price of the reduced shares must respond to the dividend in either case. The chief advantage of the reduction would be that it wiped out the old loss, and enabled them to divide at once any profits that might be made.

Several shareholders, while recognising the good work accomplished by the present board, offered a mild criticism to some of the features of the report, and one of the speakers concluded with an amendment in favour of a committee of inspection. The amendment, however, only found four supporters, and the original resolution was adopted, with the suggestion, accepted by the chairman, that the directors be authorised to write off £11,012 standing to the credit, and the reducing the assets to that extent.

Mr. John Marshall was re-elected on the directorate, and Messrs. H. W. and J. Blackburn were reappointed accountants.

The CHAIRMAN: Mr. Marshall and your directors urged upon the shareholders to assist them in raising the required additional capital. The chairman said that even if they could raise £30,000, it would mean a largely increased business.

Special meetings were afterwards held, and resolutions adopted in favour of raising the additional capital.

Victoria Electric Railway and Lighting Company, Limited.

AN extraordinary general meeting of the debenture-holders was held on Wednesday, at 8, Austin Friars, Mr. R. M. Horne-Payne presiding.

The CHAIRMAN, after stating that £1,000 of bonds had that morning been drawn for redemption at 105 per cent., remarked that immediately after the results of last year's working became known, the trustees, in accordance with the powers vested in them, paid away £43,000 in respect of liabilities. It afterwards came to the knowledge of the trustees that there existed further liabilities of between £8,000 and £10,000. As these had not been disclosed in the directors' schedule they declined to recognise them. In consequence of this action on their part they brought the company to a deadlock. One of the creditors applied to the Court for the appointment of a receiver, and this application was granted, with the distinct understanding that every penny of earnings should be held in trust for their bonds, and that all mortgages and encumbrances should be protected. The Court at the same time admitted that the debenture-holders had the right, if they desired to exercise it, to enter into possession of the property. In these circumstances it became the duty of the trustees to consider how they could best secure the interests of the debenture-holders, and, as a result, preliminary negotiations had been entered into with the Consolidated Railway of British Columbia to guarantee their bonds in consideration of receiving the surplus profits of the Victoria Company. In conclusion, he stated that the receipts for the past year showed an increase of from 10 to 12 per cent. on those of the preceding year.

On the motion of Mr. SPERLING, seconded by Mr. SIDNEY WHITE, the trustees and directors were authorised to carry out and complete the negotiations now pending for the consolidation of the Victoria Company with the Consolidated Railway of British Columbia.

Metropolitan Electric Supply Company, Limited.—This company is paying an interin dividend of 3s. per share for the half-year ending June 30th.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending November 3rd, 1895, **amounted to £971; week ending** November 4th, 1894, **£939; increase, £32; total receipts for half-year, 1895, £15,649;** corresponding **period, 1894, £15,750; decrease, £101.**

The Direct Spanish Telegraph Company. The estimated receipts for the month of October, 1895, amounted to £2,520, against £2,101 in the corresponding period of last year.

The Eastern Extension, Australasia, and China Telegraph Company. The traffic receipts for the month of October amounted to £60,288, and to £42,584 in the corresponding period of 1894, showing an increase of £17,704.

The Great Northern Telegraph Company. The traffic receipts in October, 1895, were £30,400; January 1st to October 31st, 1895, £261,600; corresponding months, 1894, £234,600; corresponding months, 1893, £223,800.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending November 3rd, 1895, **amounted to £1,046;** corresponding **week last year, £884; increase, £162.**

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 1st, 1895, **after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company,** Limited, **were £2,965.**

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Oct. 30th.	Closing Quotation Nov. 6th.	Business done during week ended Nov. 6th, 1895. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	102 —105	102 —105	...	...
1,912,880£	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	44 — 46	43 — 45	44½	44
2,993,560£	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	85 — 86	83½— 84½	85¼	83½
2,993,560£	Do. do. Defd.	Stock	...	...	...	6⅜— 7½	6½— 6⅝	6⅝	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	6½% §	...	14 — 14½	13¾— 14¼	14⅜	13⅞
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	10%‖ §	... §	2½%	3½— 4	3½— 4	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	164 —168	164 — 168	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	2 % §	1½%	3/16— 5/16	3/16— 5/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	13	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20½— 21½	20½— 21½	21 3/16	21
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5 xd	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	...	4½%	104 —107	104 —107	...	...
60,710	Direct United States Cable, Ltd.	20	3½% §	2⅝% §	2 %	8⅜— 9⅛xd	8 — 8⅛	8⅜	8 5/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	6½%	17 — 17¼	16¾— 17	17	16¾
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 % §	6 %	18 — 18½xd	17¾— 18½	17⅞	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	107 —110	107 —110	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	127 —130	126 —129	128¾	127½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17¾— 18¼	17¾— 18¼	18⅛	17¾
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	103 —107	103 —107	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	104 —107	104 —107	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	128 —131	128 —131	...	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	103 —107	103 —107	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	104 —107	104 —107	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	108 —111	108 —111	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	114 —117 %	112 —115%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞% §	4⅝% §	4½%	10 — 10½	9⅞— 10⅛	10¼	9 15/16
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 %	16⅞— 17⅛	16¾— 17¼	17 1/16	16¾
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝% §	8⅝%	8⅝%	21¾— 22¼	21¾— 22¼	22⅛	22
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	104	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	48 — 51	47 — 50 xd	48	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	106 —110	106 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	...	...	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 % §	5 %	6 — 6¼	6 — 6½	6½	6 1/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15½— 16½	15½— 16½	16⅛	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6¼— 6½	6¼— 6⅛	6 7/16	6½
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	106 —108	105 —107	107¼	105¾
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4¼%	9/16— 11/16	9/16— 11/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	109 —112	109 —112	...	...
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	5½— 6½xd	5½— 6½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	127 —132	127 —132	130	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2⅜— 3¼	2⅜— 3¼	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	92 — 97	92 — 97	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	..	...	*nil*	5½— 6½	5½— 6½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	106½	104½
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½— 2	1½— 2	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	100 —105	100 —105	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	10½— 10⅝	10 — 10½	...	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½— 7	6½— 7	...	...
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	3½— 4	3½— 4	4	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	½%	⅝%	½%	⅞— 1⅛	⅞— 1⅛	1	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10½— 10⅝	10½— 10⅝	10½	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8½— 9½	8½— 9½	8⅝	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	111 —114	111 —114	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	113 —118	110 —115 xd	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	100 —103	100 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5½— 5⅝	5½— 5⅝	...	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	...	...	...	6¾— 7¼	6⅝— 7¼	7¼	7
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	...	116 — 119	116—119	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	13 — 14	12½— 13½	13	12¾
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15½— 16½	15½— 16½	16	...
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —137	132 —136	133½	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8½— 9½	8½— 9½	...	...
10,000	Do. do. do. 6% Pref., £6 pd., 40,001—50,000	10	...	...	...	8⅝— 9¼	8⅝— 9¼	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5½%	7⅝— 8⅛	7⅝— 8⅛	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	3 %	11 — 11½	10½ — 11½	11⅜	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 —120	117 —120	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	8½— 9½	8½— 9½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	4½%	6½%	8⅛— 8⅜	8⅛— 8⅜	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	8½— 8⅝	8½— 8⅝	8 7/16	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Oct. 30th.	Closing Quotation, Nov. 6th.	Business done during week ended Nov. 6th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	6 % §	6 % §	...	1½— 1⅝	1⅝— 1⅝	1½	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	2 — 2¼	2 — 2¼	2	...
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	112 —115	112 —115	...	...
630,000£	City and South London Railway	Stock	5%	5%	1¼%	40 — 42	40 — 42	41	40
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	1½— 2½	1½— 2½	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	...	...	5 %	1⅞— 2¼	1⅞— 2¼	...	...
17,319	Do. do. do. "A" Shares 01—017,139	5	...	...	...	... ...	2⅞— 3¼	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	...	4½%	104 —107	104 —107	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	*nil*	¾— 1	¾— 1	¾	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2 — 2¼xd	2 — 2½	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	⅝— ⅞	⅝— ⅞	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅞— 1⅛	⅞— 1⅛	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	¼— ⅜	¼— ⅜	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½— 7½	6½— 7½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	14 — 14½	14 — 14½	14½	14
3,000	Do. do. do. 7% Pref.	10	...	...	...	15½— 16½xd	15½— 16½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	...	107 —110	107 —110	110	108
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	19 — 20	19 — 20	19⅜	19⅛
200,000£	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	100 —102xd	101 —103	102½	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	11 15/16— 12 1/16	11⅞— 12	...	...
10,000	† Do. do. Pref., £10 paid	10	...	5 %	5 %	15 — 15½	15½— 15⅝	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	43 — 45	42 — 44	44¼	42¼
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4⅛— 4⅞	4⅛— 4⅞	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7½%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.
Electric Construction Corporation, 6 % Debentures, 98—103.
House-to-House Company (£5 paid), 4¼—4⅜.
Do. do. 7 % Preference, of £5, 7⅜—8¼.
Do. do. 4½% Debentures of £100, 110—112.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 7⅜—8¼; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.
Liverpool Electric Supply, £5 (fully paid), 7½—8.
London Electric Supply Corporation, £5 Ordinary, ⅜—⅝.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6⅜—7¼.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

ELECTRO-METALLURGY AS APPLIED TO SILVER REFINING AND INCIDENTALLY TO OTHER METALS.*

BY GEORGE FAUNCE, B.A.S., Superintendent Pennsylvania Lead Company.

(Concluded from page 535.)

The silver is refined on the cupel until it contains not over 2 per cent. of impurities (lead, copper, bismuth). If more impure silver is treated, there is more or less bother with accumulations of copper and lead in the solutions, with consequent large amounts of bye-products, and also increased difficulty in turning out a pure product. When the silver has attained the proper degree of purity, it is cast from the cupel into flat plates about 18 inches long, 10 inches wide and ½ inch thick, weighing 425—475 ounces troy (about 30 pounds avoirdupois). These form the anodes in the electrolytic operation. Each plate has three projections or lugs on one of the long sides. Holes are punched in these lugs to receive the wires which suspend the plate in the solution. The three supporting wires ($\frac{3}{16}$ths inch diameter) are attached to a copper rod 28 inches long and ½ inch in diameter, and then the plates are ready to be placed in the tanks.

The 98 baths are arranged in sets of seven, each set being styled a *tank*. These tanks are made of 2-inch California redwood plank, joined together very carefully. The bottom is lined with sheet rubber. Each tank is 11 feet long, 24 inches wide, and 20 inches deep (inside measure), each separate cell, or bath, being 2 feet long by 18 inches wide.

The electrolyte is a solution of nitrate of silver and nitrate of copper in dilute nitric acid. The acid present is only ½ to 1 per cent. of the solution, as only just enough acid is used to prevent the deposition of copper. The consumption of acid is about 1 pint every 24 hours for each bath. The current is conducted to the baths through rods ⅝ths inch in diameter. The rods connecting the tanks are so arranged that any one or any number of the tanks may be left out of the circuit if desired.

The cathodes are thin sheets of pure silver, 13 × 20 × $\frac{1}{32}$ inches thick, weighing 50 ounces troy (3½ lbs. avoirdupois). These cathodes are rolled in the machine shop of the company, from their own silver. In each bath, four of these cathodes are suspended, alternating with three anodes. The distance between cathodes and anodes is about 1¾ inches. The rods which support the cathodes and anodes themselves rest on the main conducting rods, which are arranged horizontally along the sides of the tanks. On the side of the bath where the current enters the anodes, the ends of the cathode wires are insulated by rubber, while on the opposite side the ends of the anode rods are insulated, while the cathode rods are in direct contact with the conductor.

The current from the dynamo has an intensity of 180 ampères. It enters a bath through three anodes, and is, therefore, divided up into three parts, each with an intensity of 60 ampères. It passes out at each side of each anode, through the solution, to the cathodes, so that the intensity of the current through the solution is 30 ampères. These divisions of the main current pass out through the cathodes and are reunited in the main rod and carried to the next bath. The cells, or baths, are arranged in series, the whole current

* A lecture delivered before the Franklin Institute.

passing through each bath. Each anode is suspended in a muslin bag, which serves to collect the undissolved metals, which fall in the shape of a black slime. The metals thus caught are all of the gold and bismuth, the greater part of the lead as peroxide, together with some silver and copper. Below this system of anodes, cathodes and bags are stretched, on a box-like frame, a piece of cloth on which is gathered the deposited silver as it is scraped from the cathodes by wooden "brushes." These brushes straddle the cathodes, hugging close to each surface without touching. They are kept moving to and fro by machinery, and they serve not only to brush off the silver as fast as it is deposited on the cathodes, thus preventing short circuits, but also, by keeping up a constant agitation of the liquid, to prevent, to a large extent, polarisation and the tendency of the solution to settle into layers.

The principal points covered by the patents of Mr. Moebius relate to these mechanical stirrers, and the bags for collecting the gold slimes.

Now, we will suppose that we are running 10 tanks, or 70 baths. The dynamo is made to generate a current of 180 ampères. The voltmeter shows an E.M.F. of about 90 volts. Then, by Ohm's law,

$$R = \frac{E}{C},$$

it appears that the resistance of the circuit is ½ ohm, or about ·007 ohm for each bath. The work absorbed by this current is, by our formula,

$$W = \frac{E\,C}{9{\cdot}81 \times 75} = \frac{180 \times 90}{73{\cdot}58} = 22 \text{ horse-power.}$$

The total cathode surface per bath is 10 square feet. The current being 180 ampères, the density of the current will be about 18 ampères per square foot of cathode surface.

The current, in its passage through the solution, decomposes the nitrate of silver. Silver is deposited on the cathodes in the shape of dazzling white, coarse crystals, and nitric acid is formed. This acid attacks the anode, dissolving silver, and thus restoring nitrate of silver to the solution. The nitric acid also dissolves the copper and some of the lead, and oxidises the bismuth and the rest of the lead, making products which remain undissolved in the bags.

I have mentioned that the density of the current is 18 ampères per square foot of cathode surface. This is high compared with the density used in copper refining, and is the cause of the loose crystalline deposit, as, with a low current density, the deposit tends to become cohesive. In the case of silver, this crystalline structure is of advantage, as the silver can easily be brushed off and collected at frequent intervals. If it were deposited in a cohesive coating, either a far greater quantity of silver would need to be carried in stock, which would unduly increase the interest charges, or, one would have to be continually remelting old cathodes and making new ones, which would be expensive.

A current of 1 ampère will deposit from a solution of silver nitrate 1·12 milligrammes of silver per second; a current of 180 ampères, therefore, will deposit 201·6 milligrammes per second. According to the second of Faraday's laws, the same current will deposit equal amounts, simultaneously, in each of the 70 baths; consequently, our current should deposit 14·11 grammes per second in the whole series. This amounts to a deposition of 50·8 kilogrammes per hour, or 1,219·28 kilogrammes per day (= 39,205 troy ounces). As the horse-power expended to deposit 50·8 kilogrammes per hour is about 22, it follows that each kilogramme of silver deposited consumes about $\frac{2}{3}$ths horse-power per hour ($\frac{1}{3}$rd lb. per horse-power per hour). Although, theoretically, our 70 baths should deposit 39,205 ounces per day, in practice this yield is not obtained for several reasons:—

1. The anodes have to be drawn up out of the baths, for the purpose of cleaning up the gold and silver. This consumes considerable time each day.

2. Shorter interruptions of the deposition are necessary for replacing anodes, cleaning connections, examining insulations, &c.

3. With our small machine, which is not quite large enough for the work put upon it, constant vigilance is necessary to keep the current up to 180 ampères throughout the 24 hours, and, of course, any lowering of the intensity of the current means a proportionate decrease in the output.

The actual working results, day in and day out, will average 33,000 ounces per day for the 70 baths. We could, for a short time, deposit in the whole plant 45,000—50,000 ounces per day; but in the long run it will be found necessary to keep about $\frac{1}{7}$th of the tanks under repair all the time.

The labour required in the process is slight. A carpenter is employed constantly in repairing and rebuilding tanks, making brushes, boxes, &c. A mason and a machinist are needed about one day each per week for other repairs. Three men on day turn and one at night are all that are required to do the regular work, which consists of cleaning up and melting the fine silver, preparing the anodes and placing them in the bath at the proper time, cleaning up and refining the gold slimes, melting scrap silver, keeping connections clean and insulations perfect. Each tank is cleaned of silver every other day, and of gold once a week. A full-sized anode is dissolved in about 2½ days.

The deposited silver, as soon as it is taken from the tanks, is washed thoroughly with hot water, in order to rinse out the copper-bearing solution. It is then melted down in a large plumbago retort, which is capable of holding 18,000 ounces (or 1,200 lbs. avoirdupois). The fuel used is natural gas. Each retort melts on the average about 5 tons before breaking.

The fineness of the silver produced is 999—often 999½. Indeed, it would require no effort to produce silver 999½ fine regularly, if it were of any advantage. By repeated washing it is possible to obtain almost absolutely pure silver. We have furnished it to the mint as fine as 999·85. The gold slimes are melted, granulated and parted by acid. The resulting gold is 996—998 fine.

The electrolyte (of which I show a sample) is of a beautiful green colour, due to the presence of 4 per cent. or 5 per cent. of copper. It also contains a small percentage of lead. As has previously been stated, when these three metals are present in nitric solution, the silver (being the most electro-negative) is deposited before the others. So long as the copper and lead are not present in too large quantities, and so long as a proper amount of acid is used, the silver will be deposited in a state of absolute purity. As the copper and lead accumulate to a dangerous degree, it becomes necessary to withdraw part of the solution, and, after throwing out the silver with salt, to precipitate the copper and lead.

With large percentages of copper in the anodes, we have not been able to obtain silver fine enough to ship to the mint. Mr. Moebius, in his Mexican plants, has, I believe, treated bullion carrying 30 per cent. to 40 per cent. copper. But it is to be noted that the Mexican mint is not as strict as our own, and is satisfied to take silver containing 10 per cent. copper.

In 1891, the production of electrolytic silver in the United States was about 8,000,000 ounces, or about 13 per cent. of the total production. The production of 1892 will exceed this somewhat, owing to the adoption of the process at St. Louis, and to increased output of the Pennsylvania Lead Company. It will exceed 10,000,000 ounces.

Copper.—Shortly after Elkington obtained a patent for his process for the electrolytic refining of copper in 1866, copper refiners in various parts of the world began to adopt it, especially in England and Germany. In these countries there are plants that have been in operation more than a score of years. At the present time, the copper production of Germany, at least, is almost entirely refined by the electrolytic process. More recently modifications of this process have been very generally introduced into this country, until now, practically, all the refining of argentiferous copper is done by electricity.

In 1890, the estimated production of electrolytic copper in the United States amounted to 24,000,000 lbs., or about one-eleventh of the entire production of the country. In 1891 the amount increased to 36,000,000 lbs., or about one-eighth of the total product.

In 1892, it is estimated that at least 50,000,000 lbs., probably one-sixth of the entire output of the United States, will be deposited by electricity.

In the near future the immense output of the Anaconda mills (heretofore sent across the water) will be treated in this country, and still further increase the percentage of electrolytic copper.

The process is now in operation in 15 to 20 refineries in the United States. The largest of these are:—

The Baltimore Copper Smelting and Rolling Company, Baltimore, Md.; Balbach Smelting and Refining Company, Newark, N.J.; Boston and Montana Copper and Silver Mining Company, Great Falls, Mont.; Bridgeport Copper Company, Bridgeport, Conn.; Anaconda Mining Company, Anaconda, Mont.; Baltimore Refining Company, Baltimore, Md.; Chicago Copper Refining Company, Blue Island, Ill.; Lewisohn Bros., Pawtucket, R.I.

The total estimated capacity of all the electrolytic plants aggregates 4,000 tons per month, that is, these works running full could refine about twice as much as the estimated electrolytic production of the present year.

The general principles involved in this process are the same as those upon which silver deposition depends. The electrolyte in this case is a solution of sulphate of copper. Plates of impure copper (95 per cent. to 98 per cent.) form the soluble anodes, while the cathodes are thin sheets of pure copper. In two important modifications, called Smith's and Hayden's processes, the plate of blister copper answers as both anode and cathode. In Smith's process the plates are arranged horizontally, and the current causes the solution of copper from the under side of each plate, and a corresponding deposit on the upper side of the plate below. This upper surface receives a coating of wax, or paraffin, which prevents the deposit from cohering firmly to the impure copper. Cotton screens are placed between the plates to catch the undissolved metals. Hayden's process differs from Smith's in having the plates suspended vertically, as in the Moebius process, and in having no screens between the plates.

The copper, on account of the low density of the current, is deposited in a coherent layer in the form of a skin—not in loose crystals. In some of those plants in which pure copper is used as cathodes, these "skins" are peeled off as soon as they are thick enough to bear their own weight, and are used as cathodes. When the copper deposit has reached a certain thickness, the cathodes are removed from the bath and melted for shipment. The impurities (lead, silver, gold, arsenic and antimony) remain undissolved, drop to the bottom, and are regularly cleaned up and refined. Iron and nickel go into solution, but are not deposited, being electro-positive compared with copper. The arrangement of the baths varies in different establishments. In some they are arranged entirely in series, *i.e.*, the whole current traverses each bath; in others, the current from the dynamo is divided into several parts, each traversing a set of baths arranged in series.

A striking difference between a silver electrolytic plant and one for copper, lies in the size of the electrodes and the number in each bath, as well as the number of baths. The anodes may be 36 inches long by 24 inches wide and 1 inch thick, weighing over 300 lbs. each. The number of anodes in each bath varies from 16 to 18 up to 100. The number of baths in the larger works is from 200 to upwards of 400. Thus, an enormous quantity of metal is held in stock, compared with amount required in the Moebius process. By thus increasing the size of the electrodes, and the number in each bath, the resistance is proportionally decreased, causing a smaller expenditure of power for the same amount of copper deposited. The interest charges are of course increased. Each plant must decide for itself how far it can afford to decrease the consumption of power by increasing the quantity of metal carried in stock. Some of the large anodes require two months to dissolve, while the cathodes are left undisturbed between two and three weeks.

In order to deposit copper in large quantities daily, as is necessary in these days of fierce competition, currents of great intensity are used. On account of the low resistance, the E.M.F. required is low also. Some of the machines in use generate a current of 3,000 ampères, which means a deposition of about 8 lbs. per hour for each bath in a series. The greater number, however, use a current of 1,000—2,000 ampères. The E.M.F. varies from 6—100 volts, one or two machines going as high as 150. The anodes in this process are produced by a series of treatments of ores and mattes by fire. A large part of the cost of producing copper lies in this preliminary treatment.

Lately, two processes have come into use in Germany, which do away with fire, and which appear to be successful in obtaining an electrolyte directly from the ore in the wet way. The two processes are similar in principle, differing only in solvents used and in minor details. It is claimed that by these processes low grade copper ores, which have never repaid treatment, can now be treated at a profit.

In the Siemens process the pulverised ore, or matte, is leached with a solution of neutral ferric sulphate, which has the property of converting cupric and cuprous sulphide, as well as metallic copper, into cupric sulphate, which is dissolved. In the operation, the ferric sulphate is changed to ferrous sulphate. This solution of ferrous sulphate and sulphate of copper is conducted to the electrolytic tanks, where it serves as electrolyte. At this point a small amount of sulphuric acid is added. The anodes are carbon, consequently insoluble. The solution from the leaching vats is fed continuously into the cathode chamber, where the copper is deposited. Thence it passes to the anode chamber, where the oxygen set free by electrolysis converts the ferrous sulphate into basic ferric sulphate. It is thus that the polarisation, which is generally excessive where insoluble anodes are used, is overcome. The free sulphuric acid in the solution converts the basic ferric sulphate into neutral ferric sulphate, and the process of regeneration is complete. The solution, as it leaves the electrolytic tanks, is pumped up and used for leaching a fresh portion of ore.

In Hoepfner's process, the solvent is a solution of cupric chloride in strong brine, or in a concentrated solution of chloride of lime. This solution will dissolve the sulphide of copper and silver, with precipitation of sulphur and conversion of the copper salts into cuprous chloride. From cuprous chloride solution, nearly twice as much copper is deposited by a given current as from a solution of the sulphate. As in the other process, this solution is fed continuously into the cathode chamber, where the copper is completely precipitated. An equal amount of this same solution is fed simultaneously into the anode chamber, where the liberated chlorine converts cuprous chloride into cupric chloride. The solutions coming from both chambers are mixed together, thus regenerating the original solution.

It is stated that Siemens's process is in use in only one plant near Berlin, but that Hoepfner's process has been adopted at three places in Germany. It is quite likely that this process may soon come into prominence and mark another decided advance in the metallurgy of copper.*

Aluminium.—In no department of metallurgy has electricity achieved so great a success as in the production of aluminium. It has fairly monopolised the whole field, and driven the old chemical processes out of existence. Indeed, before the advent of electrical methods, aluminium was so expensive as to preclude its use in the arts, and the whole development of the aluminium industry may truthfully be credited to electricity. In 1855, when it was first produced in quantity, it was valued at $90 per pound. As methods were improved, the price gradually fell to $5 in 1887. In 1888 the Pittsburgh Reduction Company began to produce pure aluminium by electricity, and placed it on the market at $2 per pound. At present the metal is quoted at 50 to 65 cents per pound, according to purity. The total world production from 1860 to 1889 inclusive, is estimated by Mr. R. L. Packard at 232,000 lbs. During 1890 and 1891 alone, the production in the United States amounted to 258,000 lbs. These figures show what a revolution has been wrought by electricity in this field.

It is not my intention to enter into a detailed description of the processes in use, but I will simply mention some of the points wherein they differ from the processes already described.

The one great difference is the condition of the electrolyte. Hitherto we have spoken only of solutions. The electrolyte in the aluminium bath is in a state of fusion. It consists of

* From Vol. iii. of Rothwell's "Mineral Industry":—The production of electrolytic copper in the United States, in 1894, is given as 115,000,000 lbs. The old-established refineries, such as those of the Balbach Smelting and Refining Company, the Baltimore Electrolytic Company, and the Bridgeport Copper Company, increased their output, and several new works have been started or enlarged. Among the latter may be mentioned the works of the Nichols Chemical Company, at New York; the Boston and Montana Company, at Great Falls; and the electrolytic works of the Anaconda Company, at Anaconda, which were remodelled in 1894 on the Thofehrn plan; the works building at Salt Lake City, embracing a Bessemer and an electrolytic plant; and the large works of the Guggenheim Brothers, under construction near Perth Amboy, N.J. W.

a solution of alumina (artificially prepared from the ore) in molten cryolite, which is a double fluoride of aluminium and sodium. The electrodes are of carbon, and the passage of the current through the electrolyte generates sufficient heat to keep it melted. An enormous quantity of power is absorbed in this process, amounting, according to Mr. Hunt, the president of the company, to 22 horse-power per pound per hour.

The principal producers of aluminium and alloys in the world are: the Cowles Syndicate Company, England, the Metal Reduction Syndicate, England, the Alum. Industrié Actien Gesellschaft, Switzerland, the Cowles Electric Smelting and Aluminium Company, Lockport, N.Y., and the Pittsburgh Reduction Company, Pittsburgh, Pa.*

Lead.—Mr. N. S. Keith has patented a process for refining lead bullion, in which the method of treatment is very similar to that used in copper refining. The anodes are plates of impure lead, the electrolyte is a solution of sulphate of lead in acetate of soda. The process was entirely successful, mechanically and metallurgically; but the cost of treatment was too great, and the large works erected in New York were abandoned. It is probable this process will again be heard from in the days of cheap electricity.

Considerable interest has been manifested in electrolytic processes for recovering zinc from its ores, but nothing of value has yet been attained in that direction. Zinc is so cheaply produced by fire, the energy necessary for its electrolysis is so great, that it does not seem likely that these attempts will be financially successful in the near future.

To summarise: we have found that, within the last two decades, electricity has entered the metallurgical arena, and has achieved for itself the refining of one-sixth of the copper and silver produced in the United States (not to mention the Old World), and the production of the world's entire output of aluminium.

The processes thus far mentioned constitute about all the electro-metallurgical processes in general use at the present time. Numerous patents have been granted on processes for electrolytic treatment of various kinds of ores, and for refining metals, but as yet they have met with no great success. As electricity becomes cheaper, however, there is every reason to believe it will play an increasingly important part in the metallurgical arts.

CANADIAN ELECTRICITY SUPPLY.

In a paper read by Mr. A. A. Dion, M.A.I.E.E., before the Canadian Electrical Association recently, there is some very interesting information given on the consolidation of two systems of electric supply. The amalgamation comprised three electric light companies, namely:—The Ottawa Electric Light Company, the Chaudiere Electric Light and Power Company, Limited, and the Standard Electric Company of Ottawa.

The oldest of these companies was the Ottawa Electric Light Company, having begun its operations in 1881, and was used exclusively for arc lighting. Next came the Chaudiere Electric Light and Power Company in 1887, its business being confined to incandescent lighting and supplying power for motors. The E.M.F. being 550 volts, it was necessary to run the incandescent lamps five in series, an ingenious electro-magnetic arrangement being used to switch in a second lamp, hung on the flexible cord above its neighbour, in the event of it giving out.

In 1889 the alternating current converter system replaced the original machines. This company occupied three power houses, two employing water power and one steam. The steam power station was built in 1893 as an auxiliary station, and was occasioned by the diminution of the water through anchor ice and other causes. On the authority of Mr. C. B. Powell, who took part in the discussion which followed the reading of the paper, it appears that all the Canadian water power stations are infested periodically with anchor ice, some more and some less. There is considerable doubt as to the cause of this trouble, but it is most probably caused by water running over shallow ground, and freezing with great rapidity, and assuming the nature of snow, of melted snow that is, banking up against the water-wheels, and so diminishing the flow of water.

For years engineers have been engaged in trying to cope with this evil; but as no satisfactory means has been devised, it is found necessary to supplement the water-power stations with steam plant, if a continuous supply of electricity is to be maintained.

The Standard Electric Company, of Ottawa, was the junior company, having commenced business in 1891, and profiting by the experience of its predecessors, it made ample provisions for considerable extension of the original plant. It embraced both the alternating and continuous systems, the continuous current machines being used exclusively for supplying power to motors.

The consolidation of these three companies was carried on gradually, the supply to the consumers at no time being interfered with. Owing to having duplicate overhead mains running parallel to each other in most of the streets, *i.e.*, the mains of the separate companies, it was a matter of not great difficulty to connect most of the large consumers' installations on two or more sections, so that in the event of any section breaking down, the installation would not be completely disconnected.

The arc lamp service was kept entirely separate from the other departments; this arrangement worked in beautifully with the existing plant, the only change being the addition of a 60-light Westinghouse arc light machine. The three stations formerly occupied by the Chaudiere Company were turned into sub-stations, the Standard Electric Company's station being selected as the central station.

In the interesting discussion which followed, the question of over-running incandescent lamps was gone into somewhat thoroughly, and the opinions of some of those present are instructive. It was not claimed that over-running lamps did not shorten their lives, but it was unanimously agreed that the public had come to expect a great deal of light from the 16 C.P. lamp, and if a lamp be good, it should maintain its efficiency for a considerable time if over-run to the extent of, say, 4 per cent. The public demand a good light. Why not let them have it, even at the expense of somewhat shortening the lives of the lamps? Lamps are cheap enough now, and as Mr. Dion remarked, there comes a time in their existence when it is a charity to put an end to them.

The question of the governing of the turbines was touched upon, and it appears that great trouble has been experienced in the regulation of the water supply, especially when sudden changes of load call for immediate response.

If the governing of the turbines is anything like the governing of some of the steam engines in some of our English stations, we can extend our sympathy to our Canadian friends. No parts of central station plants have given engineers in this country more trouble than the question of governing. On it depends the success of the supply, more than any other part of the machinery. What matters it if we have the best engines that man can produce, if they will not govern within reasonable limits? The slightest variation of speed is faithfully reproduced on the lamps; 2 or 3 per cent. variation is easily noticed.

What expression constitutes the password of central station engineers when they meet, "How do your engines govern?" The reply we will neither attempt to letter nor syllable.

During the last few years great improvements have taken place in engine governors, and we have known governors hold the engines within creditable limits when the full load was suddenly taken off or put on, but still there is a wide field for further improvements, and we earnestly urge engine makers to persevere in this direction, for as certain as

* Since the delivery of this lecture there have been no radical changes in the metallurgy of aluminium. The electrolytic method of production still maintains its supremacy, and the entire product is thus manufactured. The Pittsburgh Reduction Company is at present the sole producer of the pure metal in the United States. This company has just put in operation an extensive electric plant for the metal at Niagara Falls. These works will be able to utilise 5,000 horse-power.

In Europe the Aluminium Industrié Gesellschaft, at Neuhausen (Switzerland), continues to be the largest producer. Dr. J. W. Richards estimates the world's production of the metal, in 1894, at 2,246,000 lbs., valued at $1,123,000. Of this amount there were produced in the United States 706,000 lbs., or about 30 per cent. The production of 1894 was nearly double that of 1893. The selling price of the metal in the United States was from 50 to 63 cents per pound, according to size of order and quality. Taking into consideration the large increase in the capacity of European and American works, lately made or in course of extension, the same authority believes that the production of aluminium in 1895 will be in the neighbourhood of 8,000,000 lbs., or 4,000 net tons. W.

a perfect governor is devised, so certain is the inventor's fortune made.

No doubt, from a financial as well as an engineering point of view, the consolidation of the three companies was the best that could be done.

Each of the three companies beginning in a small way, and soon finding out that to extend their fields of labour it would entail interfering with some of the rival companies' preserves, the wisest course was to amalgamate the three companies and form one large concern, which would be governed in all its branches from one common centre. The commercial production and distribution of the Board of Trade unit is now reduced to a science, and the management and directorial expenses require as much adjusting as the engineering, and as in engineering, they must be reduced to the best working limit, and to do this we must follow the example of our Ottawa friends, and consolidate as much as possible this department, which forms a serious item in some of the expenses of the smaller electric supply companies.

THE INCANDESCENCE LAMP.*

By A. BAINVILLE.

(*Continued from page* 382.)

The Testing of the Lamps.

How can we ascertain the value of a lamp; in other words, how should we proceed to test it? This question, although it appears very simple, is in reality very complex, owing to the manifold applications of the incandescence lamp and the various qualities required for these applications. As no lamp possesses all the qualifications demanded of it, we must rest contented if we find in the lamp constructed for some special application the main qualification required for this particular case, which may be common to all lamps; consequently we have to find out to what extent this quality exists in the different samples submitted to the tests. The testing of incandescence lamps should therefore, it seems, be performed on the spot, *i.e.*, when connected with the installation of which it is to form a part. To tell the truth, this is really the only practical method and the only one capable of giving absolutely certain results. However, to make tests under these conditions requires a considerable amount of time, and if we wish to ascertain the luminous power of the lamps, and also the variations of this value, we are obliged to have recourse to apparatus constructed for the purpose and requiring very delicate handling.

These various reasons have led to the adoption of methods of testing which, as a rule, do not realise any of the conditions of actual practice, but which, nevertheless, enable different makes to be compared together, if the determinations are arrived at by a uniform plan.

Such methods of testing lamps are no great guarantee to the consumer, since the special conditions of working for each particular case may exaggerate the defects as well as the good qualities of a lamp. They, however, show the relative value of the different makes in a particular case, and it is very certain that a lamp that gives very good results in this particular case will never give bad results in any other normal condition of working; from this point of view, then, the tests are of some value to consumers, and if they do not indicate the lamp best suited to their particular installations, they will at least show them which makes are the most carefully constructed, that is on the assumption that the tests are always made in an exactly similar manner, so that the different results are always directly comparable. One circumstance renders laboratory tests valuable, viz., the one resulting from the variations of current in an installation feeding incandescence lamps. This circumstance, in fact, as a rule, renders tests on the spot impossible, unless they are considerably prolonged; for as these variations generally present only a very vague periodicity, two incandescence lamps placed in position at two different moments will never be under the same conditions of working. These variations of current, which, as we know, are so fatal to lamps, are a perpetual cause of conflict between makers and consumers, they sometimes make certain good makes appear inferior, while they allow lamps of inferior quality to be disregarded to balance the doubts that exist as to the value of the results obtained. In this case the laboratory test made under well defined conditions can alone split the difference and allow the incandescence lamp of good quality to triumph over one of its most dangerous enemies, which is at the same time one of the most serious obstacles to the development of electricity: viz., a supply circuit in which the difference of potential is not constant.

The laboratory tests that serve to define the relative value of incandescence lamps should, as we have said, be carried out according to a uniform plan. This is, in fact, the only way to proceed in order to render the results obtained by different parties comparable. Although the methods of testing have been improving for some time, this rule is unfortunately not followed, and certain modes of procedure are even absolutely irrational.

In order to determine the best mode of procedure to be followed in tests of incandescence lamps, we must study attentively their practical working and find out the predominating qualities of the lamp, *i.e.*, the qualities that will be found in all cases; it is upon the study of these qualities that the test must be brought to bear. Moreover, as this test can never realise all the conditions of actual practice, we can, without disadvantage, select any conditions whatever, provided that they are always the same and consequently easily controlled.

By careful attention to this point we shall perhaps succeed in finding a method of testing possessing all the reliability desired, that can be employed with facility and certainty, and that will give rapidly accurate results. For all cases it is a method of this kind that we should be glad to see adopted by all experimentalists; it would confer a real benefit on all interested in the incandescence lamp, consumers and makers alike. For our part we are going to endeavour to define a practical method of testing, in the hope that others more competent than ourselves will take the matter up and express their opinions.

What essential qualities should the incandescence lamp possess? These qualities are three in number:

1. Constant lighting power.
2. Maximum duration.
3. Minimum consumption.

Unfortunately, the first of these qualities does not exist in any of our sources of light; it is, therefore, a quality that we cannot attain but to which we should approximate as closely as possible.

The second quality may be defined as the initial luminous power preserved for the maximum time. The third corresponds to the production, during the duration above-defined, of the maximum number of candle-hours for a given expenditure of electrical energy.

It is very evident that in practice these qualities have relative values.

Thus the most experienced eye will fail to detect differences of 20 per cent. in the luminous power of two given incandescence lamps, if their filaments have the same brilliancy, and, if their brilliancy is not the same, it will be the one that is at the highest temperature that will seem to give most light. This want of sensitiveness in the eye enables us to depart considerably from constancy of luminous power. As to the duration, the maximum will consequently be displaced, for we can, for instance, experience a fall of 20 per cent. in the initial luminous power without much inconvenience.

The minimum of expenditure does not depend solely in practice on the co-efficient of transformation of the lamp, *i.e.*, on the luminous power that the unit of electrical energy passing through the lamp is capable of furnishing; its consumption, in watts per candle, to use the customary expression, is only one factor in this expenditure; to it must be added the price of the energy, that of the lamp, and the rate of the sinking fund of this last quantity. It was this consideration that led Mr. O'Keenan to trace curves of the specific expenditure considered as a function of the hours of lighting, curves in which the specific expenditure represented the ratio of the total expenditure (the total energy consumed and the price of the lamp), to the total quantity of light supplied at the same moment expressed in candle hours. Such curves present for all lamps a minimum which Mr. O'Keenan calls the breaking point. This point corresponds to the minimum of expenditure for a given lamp. These

* *L'Electricien.*

essential qualities which we should find in an incandescence lamp vary therefore according to circumstances, and some tests, in which the quantities would be determined, as we have defined them above, would not be available for general application. We must, therefore, adopt some conventional values that are well defined and easily observed.

We might, for instance, admit the following definitions: The luminous power shall be determined by means of photometric observations in decimal candles. The luminous standard shall be selected once for all, and the observations made through the Crova trough, containing the solution described in the *Comptes Rendus du Congrès des Electriciens*, 1889. All the conditions of working being the same, the tests effected as indicated above at certain appointed intervals of time (every two hours of lighting, for instance) will be stopped as soon as the luminous power observed falls 30 per per cent. below the initial luminous power.

The duration of the lamp will be the time that it will have taken to lose 30 per cent. of its luminous power. This luminous power being that furnished by the lamp when it consumes a given number of watts per candle, this value of the duration will be affected by a coefficient in inverse proportion to the interval of time corresponding to a diminution of 20 per cent. of the luminous power. The expenditure will be equal to the quotient of the watt-hours consumed during the total duration, *i.e.*, until the luminous power has fallen 30 per cent. by the total quantity of candle-hours furnished during this time.

There is nothing special about this method as regards the performance of the tests which are carried out in the usual way; but it has the advantage of defining quantities that are independent of the conditions in which the lamps are placed, and consequently of rendering the results of all the tests thus performed directly comparable.

With the help of results obtained by these tests we could easily proceed to the study of special cases, and their interpretation would not lead to inaccurate considerations, as for instance, in the case of Mr. O'Keenan's curves. In fact, in these curves, the minimum corresponding to the moment of the duration, or the price of the unit of light furnished by an incandescence lamp, is the lowest possible; this minimum can be produced according to circumstances, sometimes before, sometimes after the permitted fall in the luminous power. As, lastly, the incandescence lamp is not to be regarded as a consumer of electrical energy, but as above all, a luminous focus, the essential point to be determined is, it seems to us, that at which this luminous focus ceases to fulfil the conditions that led to its adoption.

Another mode of testing which has not to our knowledge been employed yet, consists in the study of the lamps with a constant luminous power. This method would have the advantage of considerably reducing the duration of the tests and of bringing out very clearly one of the most important qualities of the incandescence lamp, its resistance to the variations of the current, and particularly to any increase in the difference of potential at the terminals.

Several objections may be raised against the employment of such a method. In the first place, the lamp is placed in conditions essentially different from those of practice. It does not seem to us that this is a very grave objection, since, as we have already said, no method of testing can claim to include all the conditions of practice, and we have to deal not with absolute measurements, but with comparisons; for the method to be defective, it would have, for instance, to introduce special properties, different from those, which contribute by their value, to constitute the quality of an incandescence lamp. Now, this is not the case: the only essential difference is that in this mode of working, the density of the current which passes through the filament goes on increasing, since as the section of the filament decreases, the luminous power per unit of surface must be increased, a condition which can only be realised by increasing the intensity of the current. Such a mode of working only demands from the lamp resisting qualities which are of considerable importance in all cases where there are variations in the supply circuit; it singularly shortens the duration of the lamp; nevertheless, this diminution seems in proportion to the normal durations for incandescence lamps of good quality; it exaggerates certain defects, such as those arising from want of homogeneity in the filament, or from irregularity in its section; lamps in which the vacuum is imperfect are quickly eliminated; but all these points may really be considered as advantages of the method, since it effects automatically a preliminary sorting of the lamps on trial. We will here mention a method somewhat similar to the preceding one, while eliminating the errors due to the photometric observations; this is the test in which the brilliancy is constant, or in which the temperature of the filament under observation is constant, this observation, be it understood, being regarded as through the bulb, *i.e.*, taking into account its blackening; the brilliancy would be observed by an optical method that need not be described. In this case the brilliancy would be determined for the luminous power shown by the lamp at a wattage determined by preliminary tests.

But let us return to our method of testing with a constant luminous intensity in order to define the conditions of its employment.

As we cannot hope to keep the luminous intensity strictly constant, we must repeat the photometric observations at as frequent intervals as possible, every hour for instance, carefully noting the difference of potential and the intensity of current for each measurement. The observations will be made according to the method indicated for the above mode of testing.

The duration would, in this case, become the total duration of the lamp under the conditions of the test, started with a given wattage.

The expenditure would be defined by the cost of the mean number of watts expended in the production of the number of candles given by the lamp under the conditions of the experiment, or, in other words, by the mean consumption in watts per candle.

The results obtained by this method of testing will therefore be independent of the subsequent conditions of working of the lamp, and there will, in this case, be no need to arrange as to the fall of its luminous power, as in the first method that we described.

(*To be continued.*)

EXTRACTION OF GOLD BY CYANIDE OF POTASSIUM.

We have received from Mr. J. C. Montgomerie a printed statement which contains some extremely curious documents on the discovery 43 years ago of the cyanide of potassium process of gold extraction.

It appears that the well-known metallurgist, Alexander Parkes, had told Mr. Montgomerie some years ago "that cyanide of potassium was a good solvent of gold and silver in ores, but that he wished to find some combination that would give quicker results. So far as he was concerned it was no secret, and the (foregoing) specification shows that his knowledge of cyanides was in marked contrast to the evidence given by some of the well-known scientific men of to-day, who evidently knew little or nothing about it. They seemed to be groping in the dark 50 years behind Parkes."

He had also prepared a specification, of which the following is an extract: "The third part of my invention consists in separating gold and silver from their ores or other compounds by means of cyanide of potassium, or sodium, or ammonium, or other combination of cyanogen, capable of dissolving gold or silver. In order to facilitate the operation, I prefer that the metallic compound to be operated upon should be in a state of fine division, as it is then much more readily soluble." Unfortunately this part of the specification was dropped out of the patent; and what can be the value of the exhumation of a passage of a specification which has not been filed? Still this may be a clue to the discovery of some printed statements by the late Alexander Parkes, and researches should be made for books or papers by him.

We must not forget that Alexander Parkes, in 1843, patented a process for the use of cyanide of potassium in depositing gold, and it would not be surprising if, interested as he was in the treatment of ores, he had discovered the useful application of cyanide of potassium to auriferous ores. It was also Alexander Parkes who, in 1843, was the first to deposit metals by electrolysis from metallic salts in the state of fusion.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co. *Electrical Patent Agents*, 31, *High Holborn, London, W.C., to whom all inquiries should be addressed. Copies of any of the specifications may be obtained of* Messrs. W. P. Thompson & Co., *price, post free,* 8½*d. (in stamps.)*]

NEW PATENTS.—1895.

19,734. "Improved means or apparatus for electrically igniting petroleum and other like motors." Count A. De Dion and C. Bouton. Dated October 21st.

19,745. "Improvements in and in the manufacture of plates for electric accumulators or secondary batteries." J. Korner. Dated October 21st.

19,815. "An electro-magnetic apparatus for actuating railway brakes and switches." C. M. White. (Communicated by the St. Louis Brake Company, United States.) Dated October 22nd.

19,821. "A means of producing stereotypes, electrotypes, or lithography, &c., by means of a typewriter or other mechanical apparatus." G. Hallett. Dated October 22nd.

19,828. "Improvements in electrolytical apparatus." R. Heathfield and W. S. Rawson. Dated October 22nd.

19,832. "Improvements in connection with electric propulsion." A. G. New and A. J. Mayne. Dated October 22nd.

19,833. "Improvements in connection with the electrical propulsion of vehicles." A. G. New and A. J. Mayne. Dated October 22nd.

19,837. "Improvements in electric arc lamps." T. E. Adams. Dated October 22nd.

19,838. "Improvements in electric arc lamps." T. E. Adams. Dated October 22nd.

19,839. "Improvements in dynamo generators or motors." A. De Puydt and M. Poncin. Dated October 22nd.

19,860. "Improvements in regulating electric motors." J. Devonshire. (Communicated by W. B. Potter, United States.) Dated October 22nd.

19,861. "Improvements in three-wire electric railways." J. Devonshire. (Communicated by W. B. Potter, United States.) Dated October 22nd.

19,862. "Improvements in dynamo-electric machines." J. Devonshire. (Communicated by E. Thomson, United States.) Dated October 22nd.

19,863. "Improvements in regulators for alternating currents." J. Devonshire. (Communicated by C. P. Steinmetz, United States.) Dated October 22nd.

19,866. "Improvements relating to inductance coils." R. Belfield. (Communicated by O. B. Shallenberger, United States.) Dated October 22nd.

19,925. "An automatic cut-off for atmospheric gas burners and electrical heating stoves." C. G. Norton. Dated October 23rd.

19,934. "Improvements in a process and apparatus for the electrolytic production of metallic zinc and metallic copper from zinc ore containing copper, and oxygen gas as a bye-product." C. A. Burghardt and G. Rigg. Dated October 23rd.

19,947. "Improvements in electric contact devices." C. Moradelli. Dated October 23rd.

19,973. "Improvements in or connected with electric lamps." W. J. Davy. Dated October 23rd.

19,989. "An electrical 'tell-tale' or watchman's recorder." J. W. Fletcher. Dated October 24th.

19,992. "Improvements in the method of laying an electric cable for tramways or railways, and in the means of communication between the conductor and the car." C. Barlow. Dated October 24th.

20,028. "Improvements in the brushes of dynamos." F. J. Chaplin and R. Chaplin. Dated October 24th.

20,047. "An improvement in the caps of incandescent electric lamps." The Edison and Swan United Electric Light Company, Limited, and A. Woodley. Dated October 24th.

20,048. "Improvements in or pertaining to electrically driven pumping apparatus." F. E. Elmore. Dated October 24th.

20,071. "Improvements relating to electric railways." A. Philippi. Dated October 24th.

20,073. "Improved means to be employed in the production of sheets or strips, or equivalent forms of metal by electro-deposition." S. O. Cowper-Coles. Dated October 24th.

20,127. "Improvements in apparatus for the manufacture electrolytically of tubes and other articles of circular section." F. E. Elmore. Dated October 25th.

20,131. "An improved manufacture of secondary or storage battery plates." P. Opitz and W. Petschel. Dated October 25th.

20,132. "Improvements in generating gases or steam by electricity from water, oil, or other suitable material." J. H. Dunn and L. J. Parsons. Dated October 25th.

20,164. "Improvements in or connected with the production of metal in sheets or other form direct from zinc ores, applicable in part for use in the electrolytical deposit of metals generally." S. O. Cowper-Coles, M. Ulcoq, W. M. Guthrie, and C. R. G. Smythe. Dated October 25th.

20,214. "Improvements in tubular galvanic batteries." E. S. Boynton. Dated October 26th.

20,215. "Improvements in double-fluid galvanic batteries." E. S. Boynton. Dated October 26th.

20,216. "Improvements in galvanic batteries." E. S. Boynton. Dated Octobor 26th.

20,237. "An improvement in electric safety fuses." The Edison and Swan United Electric Light Company, Limited, and C. F. Proctor. Dated October 26th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS. 1895.

57. "A method of ascertaining the difference of electric potential at a distant extremity of conductors." J. Hopkinson, 5, Victoria Street, Westminster, London. Dated January 1st. Relates to a method of ascertaining the difference of electric potential at a distant extremity of conductors. Near points of the conductors are connected through suitable resistances to each other and the meeting point of these connections is joined through a cell of known voltage and galvanometer to another point on one of the conductors selected so that the galvanometer is in balance when the difference of potential at the distant extremity of the conductors is that for which the resistances and cell are adjusted. 3 claims.

3,548. "Improved electric switch." W. Edge. 25, Tabard Street, Borough, London, S E. Dated February 19th. A rod of insulating material tipped at its end with conducting material forming the bridge piece is actuated by a pivoted lever to slide backwards and forwards in guides. The bridge piece in one position of the rod connects the terminals, and in the other position of the rod the terminals are disconnected. 1 claim.

3.903. "An improvement in electrical conductors." H. D. Fitzpatrick, Glasgow. (The Electric Bell and Resistance Company, 46, Lawrence Street, Newark, New Jersey, U.S.A.) Dated February 23rd. Relates to forming the conductor of carbon or carbonisable material instead of the ordinary metallic cores at present employed. An ordinary cord of cotton or the like is subjected to carbonisation in any well known manner, and is then surrounded by a braiding of cotton thread so braided as to take up all lengthwise strains. Or the core may be insulated with rubber if desired. After the cord is thus prepared metallic tips are electro-plated on its ends. Such a conductor may be used for rheostats, measuring instruments, or where conductors of high resistance are required. 4 claims.

11,864. "An improved plate for electric accumulators or storage batteries." J. Ribbe, 19, Lessingstrasse, Berlin. Dated June 18th. Relates to an improved plate for electric accumulators or storage batteries, consisting of two carrying plates of non-conducting material cemented together by means of acid-resisting material, and having chambers or recesses for receiving the paste, such chambers being curved inwards and enframed by insulating material. 3 claims.

13,404. "Improvements in dynamo electric machinery." F. H. Royce, Eastbourne, Holland Road, and E. A. Claremont, Electron, Cavendish Road, both of Chorlton-cum-Hardy. Dated July 12th. Alternating generators or motors. Plates of soft iron forming the armature core are secured to the framing by bolts which also secure to these plates, the field magnetising coil. This part of the generator or motor is stationary. The shaft of the revolving wheel is provided with pole-pieces at intermittent and regular spaces around its periphery, and causes magnetism to intermittently pass through the parts of the plates surrounded by armature coils inducing currents in them. 1 claim.

13,411. "Improved methods of distributing power by electricity." F. H. Royce, Eastbourne, Holland Road, Chorlton-cum-Hardy, and E. A. Claremont, Electron, Cavendish Road, Chorlton-cum-Hardy. Dated July 12th. In the three-wire system the voltage of one side is arranged to be greater than that of the other, for instance, on one side the voltage could be 150 and on the other 50. Motors are then used wound for the maximum voltage obtainable from the outside wires of the system and suitably connected to any two of the wires, so that, as in the instance mentioned, various speeds of the motors are obtained by these different voltages, without having to insert a resistance in the motor circuit. 1 claim.

13,564. "Improvements in and relating to electric regulators." W. V. Bonsor, 126, Gladstone Road, Wimbledon. Dated July 15th. An electric motor is employed, the armature having two distinct circuit windings. One connected in series with the circuit to be controlled, the other in shunt. The series and shunt coils are alternated round the core, each tending to rotate the armature in opposite directions, the resultant force when present being utilised to move the controlling apparatus, and restore a condition of equilibrium. The invention is described as applied to an arc lamp. 3 claims.

14,114. "Electrical apparatus having movements determined by variations of the electrical resistance of bismuth in a magnetic field." J. Hessberger Niedersedlitz, near Dresden. Dated July 24th. Relates to apparatus in which advantage is taken of the fact that the electrical resistance of bismuth and alloys of bismuth increases within practical limits proportionately to the strength of the magnetic field. Claim 1: Electrical apparatus, instruments and machines, in which variations of the electrical resistance of bismuth or bismuth alloys in a magnetic field are employed for varying a motive current, and so producing or maintaining relative motions of fixed and movable conductors or magnets. 2 claims.